NTNU – Trondheim
Norwegian University of
Science and Technology

Digital Measures Against Risky Behavior in Traffic:

Virtual Simulation of a Traffic Accident

Agnethe Søraa

Master of Science in Computer Science
Submission date: June 2015
Supervisor: Dag Svanæs, IDI

Norwegian University of Science and Technology
Department of Computer and Information Science

NTNU

Digital Measures Against Risky Behavior in Traffic:

Virtual Simulation of a Traffic Accident

TDT4900 - 08. June, 2015

Author:
Agnethe Søraa

Supervisors:
Dag Svanæs,
Terje Røsand

Department of
Computer and Information Science

Abstract

Adolescents are significantly overrepresented in traffic accidents. In fact, traffic accidents are the most frequent cause of death among them. Therefore, the overall purpose of this research project is to contribute in the strive towards a transport system with no lost lives. More specifically, it aims explore how technology can persuade adolescents to avoid risky behavior in traffic. Additionally, to obtain some guidelines for how such technology should be designed.

Three different medias were evaluated to accomplish these goals: an Oculus Rift simulation of a traffic accident (created particularly for this research project), a traffic safety campaign video, and an educational computer game called Real Life Auto. Two experiments were conducted. Due to the close relation between presence and persuasion, the first experiment was a presence test. This test measured presence and immersion in the Oculus Rift simulation to review the feasibility of designing such simulations for persuasive purposes. The second experiment aimed to investigate whether any of the medias could persuade adolescents to avoid risky behavior in traffic. Furthermore, to reveal which media was considered the most persuasive. Lastly, to discover factors having a positive or negative impact on behavior change.

The results showed that the simulation produced a high level of presence, such that it gave an uncomfortable feeling connected to traffic accidents. Hence, the simulation was evaluated as suitable for persuasive purposes, which shows that it is possible to create such simulations. Furthermore, it was considered to the most powerful media among all three. On the other hand, the campaign video was not viewed as particularly influential due to the lack of realism and the exaggeration. Additionally, Real Life Auto was evaluated as less persuasive due to educational content unsuited for the target users.

Sammendrag

Ungdom er betydelig overrepresentert i trafikkulykker. Det er faktisk den hyppigste dødsårsaken blant dem i dag. Derfor er hensikten med dette forskningsprosjektet å bidra i arbeidet mot et trafikksystem uten tapte liv. Mer spesifikt er hensikten å utforske hvordan teknologi kan bidra til å overbevise ungdom til å unngå risikofylt adferd i trafikken. I tillegg er hensikten å finne retningslinjer for hvordan slik teknologi bør utformes.
For å oppnå disse målene ble tre ulike medier evaluert: en Oculus Rift simulering av en trafikkulykke (laget av forsker), en trafikksikkerhetsvideo, og til sist et pedagogisk dataspill kalt Real Life Auto. Det ble totalt gjennomført to eksperimenter. På grunn av den nære sammenhengen mellom følelsen av tilstedeværelse og innlevelse og en slik simulering sin evne til å overtale, så var det første forsøket var en tilstedeværelsestest. Denne testen målte nettopp tilstedeværelse og innlevelse i simuleringen. Målet var å finne ut om det var mulig å utforme simuleringer ment for overbevisende formål. Det andre eksperimentet undersøkte om noen av mediene faktisk kunne overbevise ungdom til å unngå risikofylt adferd i trafikken. Videre, forsøkte det å avsløre hvilket medie som ble ansett som den mest overbevisende. Til slutt, var målet å oppdage faktorer som hadde enten en positiv eller negativ innvirkning på atferdsendring.
Resultatene viste at simuleringen produserte en høy grad av tilstedeværelse og innlevelse. Graden av tilstedeværelse og innlevelse var så høy at det gav deltagerne en ubehagelig følelse knyttet til trafikkulykker. Av den grunn ble simuleringen evaluert som egnet for overbevisende formål, noe som igjen viser at det er mulig å designe slike simuleringer. Videre ble simuleringen ansett som det mest overbevisende mediet blant alle tre. Kampanje videoen ikke sett på som spesielt innflytelsesrik på grunn av mangel på realisme og at den ble litt overdreven. I tillegg ble Real Life Auto vurdert som mindre overbevisende på grunn av for pedagogisk innhold som var uegnet for målgruppen.

Preface and Acknowledgements

This report is the result of the master thesis conducted in the last semester of the masters degree program at the Norwegian University of Technology and Science. The research was conducted for the Department of Computer and Information Science.

I would like to thank my main supervisor, Professor Dag Svanæs, for much-appreciated guidance and feedback throughout the whole semester. Also, I would like to thank my co-supervisor, Terje Røsand, for guidance and for helping me with the equipment at the NSEP usability laboratory.

I would also like to thank Magnus Jordheim and Knut Ove Børseth at Trygg Trafikk for helping with the recruitment process. Additionally, I would like to thank Gunnar Jenssen, Terje Moen, and Dagfinn Moe at Sintef for their valuable input.

Lastly, I would also like to thank all the participants who attended both of the experiments conducted during this research project.

Agnethe Søraa
Trondheim, 08. June, 2015

Contents

List of Figures

List of Tables

List of Acronyms

ITQ Immersive Tendency Questionnaire.

NESP Norwegian Center for Electronic Patient Journal.

NTNU The Norwegian University of Science and Technology.

OR Oculus Rift.

PQ Presence Questionnaire.

RLA Real Life Auto.

SSQ Simulation Sickness Questionnaire.

VR Virtual Reality.

List of Glossaries

Attitude is a relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols [1].

Behavior is a response of an individual/group to an action, environment, person or stimulus [2].

Immersion is the feeling of being involved in the experience [3].

Perception is defined as the way in which something is regarded, understood, or interpreted [2].

Persuasion is an attempt to change attitudes or behaviors without coercion or deceptions [4].

Persuasive technology is interactive technology that attempts to change attitudes and behaviors, where the behavior is pre-determined [5].

Persuasiveness is ability to persuade. See persuasion.

Presence is the subjective experience of being in one place or an environment, even when one is physically situated in another place or environment [6].

Simulation sickness can occur when there is a disparity between senses during a virtual reality simulation, and it gives uncomfortable symptoms [7].

Virtual reality is a medium composed of interactive computer simulations that sense the participant's position and actions, providing synthetic feedback to one or more senses, giving the feeling of being immersed or being present in the simulation [8].

Part I

Introduction

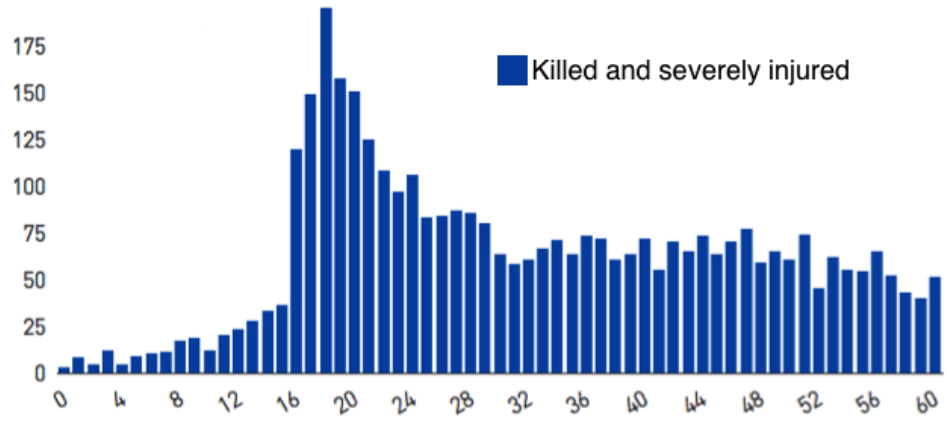
1 Introduction

This chapter introduces the purpose and motivation for this research project. It also contains the research questions being investigated. Additionally, it describes the target users, the context of use, as well as methods used. Lastly, this chapter describes the limitations for this study.

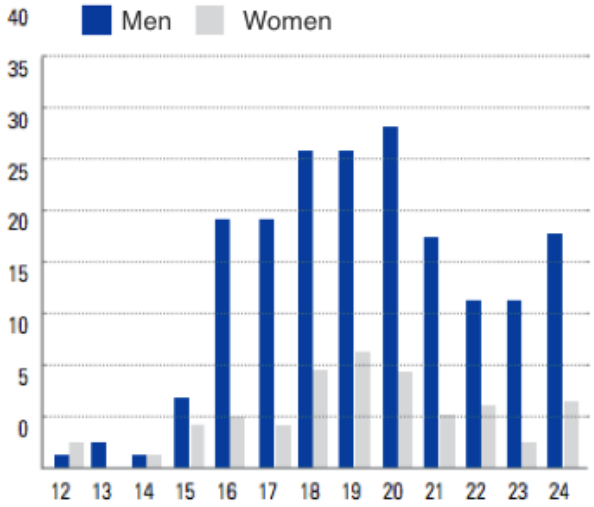
1.1 Purpose and Motivation

Trygg Trafikk is an organization that works with traffic and traffic safety [9]. They are both a partner and an advocate for the Norwegian government. Together with the Norwegian government they have a "Vision Zero". Vision Zero is a strive towards a transport system that has no lost lives. This vision requires a long-term, systematic and focused work. Through Trygg Trafikk's constant and continuous work regarding traffic safety, they provide vital knowledge and information in an attempt to reach this vision.

A report from Trygg Trafikk shows that adolescents are significantly over-represented in traffic accidents in Norway [10]. It is possible to see this from Figure 1.1(a), which shows number of killed or severely injured distributed by age. Furthermore, the report also states that among adolescents, the numbers of deaths caused by traffic accidents are higher than the number of deaths caused by violence, alcohol, and diseases. Hence, it is the most frequent cause of death among them today. Additionally, boys are significantly higher represented compared to girls, which is possible to see from Figure 1.1(b). In fact, the report shows that boys constitute about two-thirds of the fatalities and that the girls are often passengers in these accidents.



(a) Age Distribution



(b) The Distribution of Males and Females

Figure 1.1: Traffic Accidents

The report from Trygg Trafikk mentions various causes of the adolescents over-representation in traffic accidents. First, they lack driving experience. Secondly, they are more frequently "speeding" compared to older drivers. Moreover, lack of driving experience and speeding composed, is a common basis for losing control and run off the road. Thirdly, driving under the influence of alcohol causes several accidents, which statistics implies adolescent do more frequently than elder drivers. Also, the young drivers take more deliberate violations. Lastly, not wearing a seat belt is also a common problem among adolescents.

In an attempt to change adolescents behavior, Trygg Trafikk developed an online game, Real Life

Auto, (see Figure 1.2). The purpose of RLA was to persuade adolescents to avoid risky behavior in traffic by increasing awareness of the subject and teaching about the severe consequences. RLA's persuasive effect on the target users (see Section 1.3) were measured in the pre-project (i.e. the preliminary project of this master thesis). However, it did not have the desired effect. Based on the results from this project, it was derived that a new improved version of the game should be developed. Another recommendation was to develop an entirely new game. More details about the results from the pre-project are presented in Section 5.1. Furthermore, during the experiments in the pre-project, several participants stated that they did not believe in behavior change unless these adolescents experienced a traffic accident for themselves.

Figure 1.2: Real Life Auto

Therefore, to learn more about post behavior after traffic accidents, the research institute Sintef [1] was contacted. In 2009, they did a report regarding the usage of seat belts [11]. They investigated what caused people to not wear them and what measures could be done to increase the usage. During this study, they conducted in-depth interviews with twenty people who had experienced traffics accident and not worn the seatbelt. One of the questions was related to learning and behavior change in retrospect. The result showed that an accident had a significant effect on their perception of the importance of wearing the seat belt in hindsight. Additionally, it showed that those who previously did not wear a seatbelt regularly, now always wore it. Moreover, some even insisted everyone else wearing it as well. In conclusion, the results indicated that experiencing an accident had an effect on behavior change.

Based on the findings of the pre-project and the Sintef report, an idea of creating an Oculus Rift simulation of a traffic accident occurred. It is possible to read more about Oculus Rift, OR, in Section 6.1. The argument for using Oculus Rift was grounded in the technology's ability to give the users a first-person view. However, such a simulation would only give a virtual experience of a traffic accident in contrast to a real life experience. On the other hand, research by [12] (see Section 4.1) indicated that a focusing on emotional intensity feedback could be persuasive. Therefore, it was

[1] http://www. http://sintef.no/

decided to develop a prototype of an Oculus Rift traffic accident simulation. The purpose was to find out if it was possible to create an OR simulation suited for persuasive purposes, and if experiencing a simulated traffic accident could have a cause behavior change among adolescents.

Additionally, there exist other medias with the purpose of changing people's risky behavior in traffic. First, there are several campaign videos (see Section 5.2). Secondly, the computer game Real Life Auto was created with a persuasive purpose. However, relatively little research have been conducted to compare the persuasive effect such medias. Moreover, research discovering what achieves behavior change regarding risky traffic behavior among adolescents.

Therefore, the goal of this research is to investigate three medias: an OR simulation, a campaign video, and RLA. The goal is to find out if it is possible to create an OR simulation suited for persuasive purposes. Secondly, to reveal id any of the three medias are considered persuasive by the adolescents. Furthermore, to reveal which one is considered the most persuasive. Lastly, to the goal is to discover factors that have a positive or negative impact on such persuasive technologies.

In summary, these are the medias being tested during this research project:

- **The Oculus Rift simulation:**
  A prototype of an Oculus Rift simulation was created by me as the researcher particularly for this research project, and it is possible to read more about the implementation in Chapter 10.
- **A campaign video:**
  A campaign video was chosen from the video streaming service, YouTube.The details of the chosen video is presented in Section 5.2.1.
- **Real Life Auto:**
  The computer game RLA, was created for persuasive purposes by Trygg Trafikk, and it is possible to read more details in Section 5.1.

The motivation for this research project is to understand technology intended for behavior change (i.e. persuasive technology, see Chapter 2), and to explore how such technology can contribute towards vision zero. Hopefully, the outcome of this research can be useful in the creation of new persuasive technologies and ultimately help reduce the high number of deaths among adolescents as a consequence of risky behavior in traffic.

1.2 Research Questions

This section presents the research questions this project will answer. In total, there are three research questions. After each question, there is a description of the goal and motivation of the question.

The goal of the research is to discover if is possible to create OR simulations suited for persuasive purposes. Additionally, the research aims to reveal if each of the medias is considered persuasive (i.e. persuading them to avoid risky behavior in traffic) by the target users. Next, the goal is to find out which media is considered the most persuasive. Lastly, the research attempts to discover factors that have a positive or negative impact on behavior change.

The overall purpose of the research project is to explore how technology can contribute to the work toward vision zero, and ultimately reduce the high number of deaths among adolescents as a consequence of risky behavior in traffic.

1. *Does the Oculus Rift simulation produce an experience of presence and immersion, such that the user feel it could be a real traffic accident?*

   It is challenging to use a virtual reality simulation as a persuasion media if the target users do not feel present or immersed in it [13] (see Section 4.3). Therefore, due to the relevance of presence and immersion when assessing virtual reality simulations, this research question is required. Consequently, the users' experience of presence and immersion in the OR simulation will be measured. Moreover, it will be measured through a presence test (a presence questionnaire, a simulation sickness questionnaire, and semi-structured interview) created based on the literature. It is possible to read the details regarding measurements of presence and immersion in Section 3.6. The answer to the question will be based on the analysis of data from this test, and the answer will assess if it is possible to create OR simulations suited for persuasive purposes.

2. *How do the users assess the effect each of the medias, the simulation, the campaign video and RLA, has on attitude, behavior and perception change for both themselves and other teenagers?*

   The second question addresses the target users' subjective assessments of each medias' persuasive impact. The participants will evaluate to which extent they believe each of the three medias can change attitudes, behaviors, and perceptions. These factors are relevant since they are the fundamental concepts of persuasion (see Section 2.1). Furthermore, they will evaluate the impact on both themselves and teenagers in general. This question will be answered based on an analysis of data collected through questionnaires and semi-structured interviews.

3. *Comparing the simulation, the campaign video, and Real Life Auto, which media is considered more effective regarding behavior change?*

   The third question compares the Oculus Rift simulation, the campaign video, and Real Life Auto. The goal is to reveal which media the target users determines as the most persuasive (i.e. persuading the target users to avoid risky behavior in traffic). The data will be collected by using questionnaires and card rankings. The answer will be based on the quantitative analysis of this data.

4. *What factors of the three media do the target users assess to have a positive or negative effect on behavior change?*

   The last question aims to discover possible factors of the three media that have a positive or negative impact on persuasion (i.e. persuading the target users to avoid risky behavior in traffic). The answer to this research question will be based on an analysis of the qualitative data from the card ranking and the semi-structured interviews.

1.3 Target Users

The target users in this research project are adolescents, due to their over-representation in traffic accidents. It is particularly boys that like driving, speeding and does not have the best impulse control. However, girls are also at risk. The goal is to persuade the target users to avoid risky behavior in traffic.

1.4 Context of Use

The context of use for the OR simulation could at school or a traffic school or traffic station. Regarding the campaign video, the context of use is watching it at home on a laptop. Such videos could go viral on the internet. In addition, they could also be used as a "commercial" before watching other videos on YouTube or similar channels for video sharing. The situation of use for the computer game, Real Life Auto, would be at home. It could also be used as a part of a school course. However, this project focuses on testing and experiencing the media rather than finding the of the perfect situation of use.

1.5 Research Methods

This research project includes a range of qualitative and quantitative research methods used to gather data, and it will be collected during two different phases.

In the first phase, a presence test will be performed on the Oculus Rift simulation created. The test aims measure presence and immersion, which is possible to read more about in Chapter 4. During this test, data is collected through questionnaires and semi-structured interviews. The details regarding the presence test is presented in Section 9.1.

In the second phase, a persuasive test will be conducted on the target users. The goal is to discover the persuasive impact of each of the three medias. Additionally, it is to reveal which media the target users determines as the most persuasive. Lastly, to discover possible factors that have a positive or negative impact on persuasion. It is possible to read more about persuasion in Chapter 2. During this test, data is collected through questionnaires, card rankings, and semi-structured interviews. The details of this test is presented in Section 9.2.

Lastly, to answer the research questions, quantitative and qualitative analysis methodologies were performed on the data. It possible to read about this in Section 7.7.2 and Section 7.7.1.

1.6 Limitations and Ethical Issues

All participants in this research project attended voluntarily. At the beginning of each experiment, they were requested to sign a written consent form stating that they knew it was voluntary. Additionally, that they agreed to be video recorded during the session. All video recordings were kept on one password-protected laptop, and everything will be deleted at the end of the project.

Quotations from participants during the test were translated from Norwegian into English, which means they might not be exact. However, the meaning of the content were not changed.

All participants were involving and engaging. However, such personalities might not generalizable for all the target users. Additionally, the number of participants in the persuasive test were too low be representative for the whole intended user group. The validity of the research project will be discussed further in Chapter 18.

The first research question in this project is concerned with measuring presence. However, measuring presence is complex. There is no scientifically accepted definition of it, and there is no standard methodology. Therefore, this research project uses the target users' subjective evaluations of their experience of presence. However, that makes it is challenging to draw conclusions. These results can only obtain indications about the users' experience of presence.

Lastly, evaluating persuasive technology is challenging. It is it especially challenging with this short time frame. One way to measure the persuasiveness of a technology would be to follow some target users over several years, and having them test the technology with regular intervals, and then compare the results. However, it would be challenging to determine if a behavior change were caused by the technology or other factors in life. Therefore, the conclusion of this research will be based on the target user's subjective evaluations of the three medias. Additionally, if the results show that a media is persuasive, this is not scientifically proven. The results of this research project can only indicate if a media has a persuasive effect.

1.7 Readers Manual

Part 2 - Background: Presents the underlying background theories for this research project.

- Chapter 2 - Describes the fundamentals of persuasion and persuasive technology.
- Chapter 3 - Defines virtual reality, and describes the fundamentals.
- Chapter 4 - Describes the connection between virtual reality and persuasive technology.
- Chapter 5 - Describes Real Life Auto and the campaign video.
- Chapter 6 - Describes the different technologies used.

Part 3 - Research Methods and Research Design: Describes research methods and the research design practiced in this research project.

- Chapter 7 - Describes the research methods used in this research project.
- Chapter 8 - Describes the different areas of validity that will be addressed in the discussion.
- Chapter 9 - Presents the design of this research.

Part 4 - Implementation of the OR Simulation: Describes the implementation of the Oculus Rift simulation.

- Chapter 10 - Describes the implementation of the simulation.

Part 5 - Research Procedure and Results: Presence Test: Presents the research procedure of the presence test and the associated results.

- Chapter 11 - Describes how the presence test was conducted.
- Chapter 12 - Presents the results of the presence test.

Part 6 - Research Procedure and Results: Persuasive Test: Presents the research procedure of the persuasive test and the associated results.

- Chapter 13 - Describes how the persuasive test was conducted.
- Chapter 14 - Presents the results of the persuasive test.

Part 7 - Discussion and Conclusion: Present the analysis of all the results, the validity, and lastly, the conclusion of this study.

- Chapter 15 - Discusses the results in relation to the research questions.
- Chapter 16 - Discusses the research questions relation to each other.
- Chapter 17 - Discusses the research in relation to the background theory.
- Chapter 18 - Addresses the validity of the study.
- Chapter 19 - Concludes this study, and suggests further research.

Part II

Background

2 | Persuasive Technology

This chapter describes the background information regarding persuasive technology. The first section defines persuasion. The next sections describe the persuasive technology and the necessary fundamental frameworks within this research area.

2.1 Persuasion

According to [14], [15], [16], persuasion is: "an attempt to shape, reinforce or change behavior, feelings or thoughts about an issue, object or action." Furthermore, according to [4], persuasion is: "an attempt to change attitudes or behaviors without coercion or deceptions." It is possible to see that persuasion is concerned with changing attitudes and behaviors, which means these terms are fundamental concepts of persuasion.

An attitude is considered the single most important concept in social psychology [17]. [1] defines it as: "a relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols." Furthermore, according to [18], attitude and behavior are strongly connected to each other. A behavior is defined as "a response to an individual or a group to an action, environment, person or stimulus" [2]. Also, according to [18], an intention to perform a behavior is based on a weighted sum of attitudes toward the behavior, as well as the subjective norms related to it. Another connection between the terms is found in a model proposed by [19]. This model explains the process by which attitudes guide behavior, and it views behavior as a function of the individual's immediate perceptions of their attitude.

Further, according to [20], a behavior is also related to perception. Perception is defined as the way in which something is regarded, understood, or interpreted [2]. They argue that behavior is the final touchstone of the presence or functioning of perception, and there is no "theory of perception" without a theory of behavior." That means someone's perception and attitude toward a behavior indicate how that person will act in a given situation [21].

In summary, it is evident that attitude, behavior, and perception are strongly connected to each other. Moreover, they are fundamental concepts of persuasion.

2.2 Persuasive Technology

A lot of research has been conducted to examine if a technology can persuade users similar to how humans can persuade each other. The results are clear: it can. People can respond to some computers systems as they were living beings [22]. A possible explanation is that the human's social responses come automatic and natural [23]. People are hardwired to respond to cues in the environment, and especially to things that seem alive. These responses are instinctive rather than rational. Computer systems can simulate humans social dynamics that in some way makes them appear living [24], [25], which means the social persuasion dynamics that arises from social situations can be used in technologies as well. These results are built upon results, theories and methods of experimental psychology and human-computer interaction. This particular field of study is called captology, and [26] defines it as: "the study of computers as persuasive technology." It is possible to see more details in Figure 2.1.

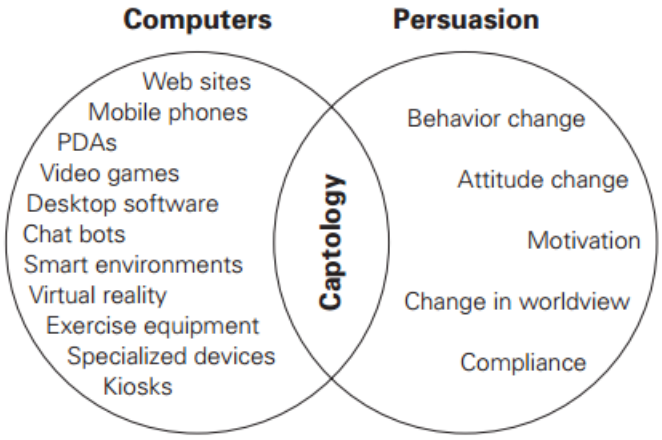


Figure 2.1: Captology - The Intersection between Technology and Persuasion

According to [14], persuasive technology is interactive technology that attempts to change attitudes and behaviors. However, there is a significant difference between a technology's side effect and it's planned effects, and the latter is the goal when it comes to persuasive technology. Consequently, the target behavior is predetermined [5], and it considered to be a particular case of design with intent.

However, computers do not have intentions. Therefore, it qualifies as persuasive technology when those who create, distribute or adopt the technology do it with the intent to affect human attitudes or behaviors [27]. The technology inherits the intent from the human actors, and there are three kinds of inherited intents [14], [28]. They can fall into more than one category.

- **Endogenous** intent is when those who create the technology or a producer has an intent to persuade the user in a particular way.
- **Exogenous** intent is when a person provides another person with a computer technology in

an attempt to change their behavior.

- **Autogenous** intent is when a person chooses to use or adapt to a technology in order to change their behavior.

2.3 Fogg's Functional Triad of Computer Persuasion

According to Fogg, persuasive technology functions in three basic ways: as tools, media, or as social actors. These aspects are referred to in the literature as the functional triad of computer persuasion. It is possible to see this it in Figure 2.2. Each corner represents a different pathway to persuasion.

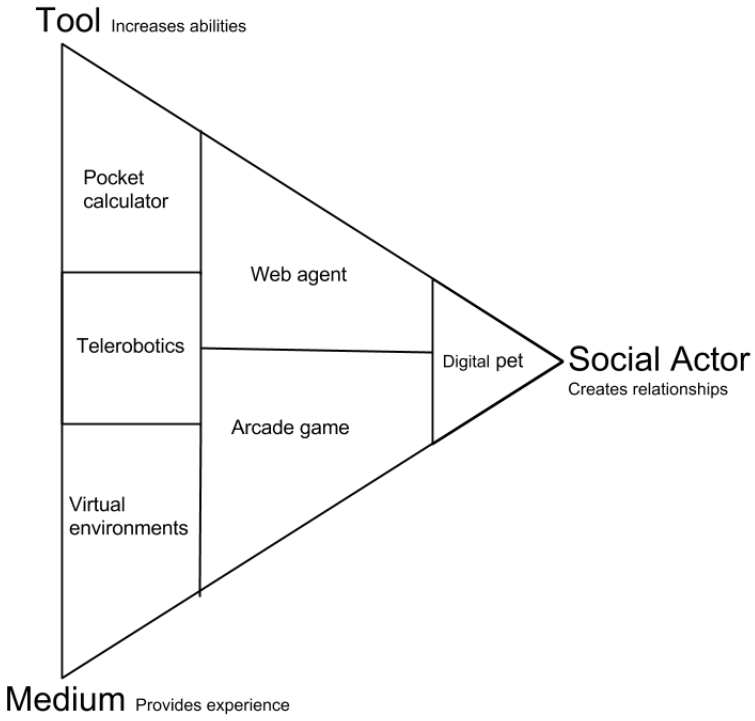


Figure 2.2: Fogg's Functional Triad of Computer Persuasion

Fogg argues that as a tool, a computer application can provide humans with new abilities or providing experience, allowing them to do things more easily. As a media, a computer can convey either symbolic content (e.g. text, data, graphs, icons) or sensory content (e.g. real-time video, simulations, virtual worlds). Lastly, as a social actor it can invoke social responses from users by leveraging the power of social relationships. That can happen if a computer system adopts animated characteristics (e.g. physical features, emotions, voice communication). It can also happen if a computer system plays animated roles (e.g. coach, pet, assistant, opponent). Or it could occur

if a computer system follow social rules or dynamics (e.g. greetings, apologies, turn taking) 2.1. Table 2.1 highlights some of the persuasive affordances in each corner case. Fogg's triad helps to understand all the techniques on how to influence people's attitudes or behaviors [5].

Function	**Essence**	**Persuasive affordances**
Tool	Increases capabilities	• Reduces barriers (time, effort, cost) • Increases self-efficiency. • Provides information for better decision-making
Medium	Provides experience	• Provides first-hand learning, insight, visualization. • Motivates through experience
Social actor	Creates relationships	• Establishes social norms. • Invokes social rules and dynamics. • Provides social support.

Table 2.1: Persuasive Affordance

2.4 Fogg's Behavioral Model

It is useful to take a closer look at the human behavioral model by B.J. Fogg [29] to understand how technology can persuade. This model aims to explain the human behavior, and the factors needed to change human behavior. The research done in this area shows that a human behavior is a product of three factors: motivation, ability, and triggers. In persuasive technology, these three factors has to happen simultaneously to get the targeted behavior [29], [30]. These three factors and their subcomponents is shown in Figure 2.3.

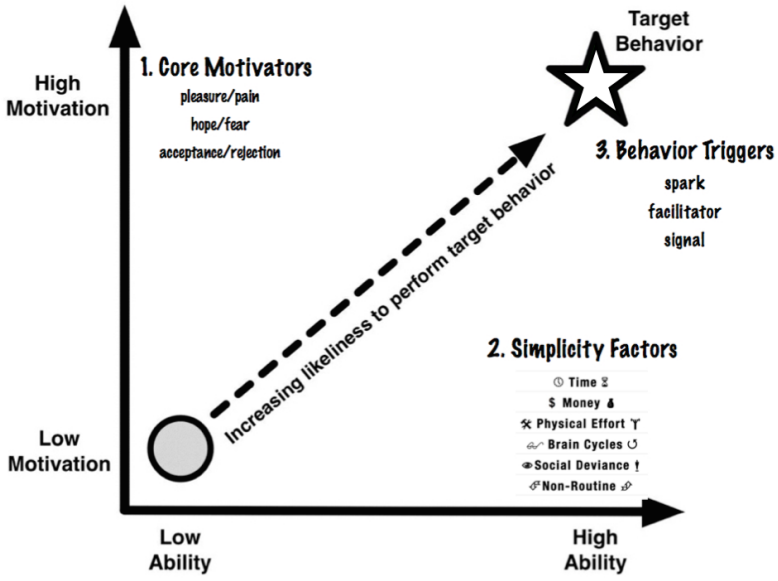


Figure 2.3: The Behavior Model

- **Core Motivators**
  The first the core motivator is: "sensation". Sensation has two sides that motivate humans to have certain behaviors: pleasure and pain. In general, humans are highly motivated to achieve pleasure. On the other hand, they are also highly motivated to avoid pain. For these reasons, a behavior as the result of sensation are often immediate and on impulse. Thus, there is little time to evaluate actions, which causes persuasion to be easier [29]. Therefore, Fogg argues that sensation is a very powerful motivator.

  The second core motivator is anticipation, which has two sides. The first is hope, which is motivation based on the hope of something good happening. The second is fear, and it is motivation based on the fear of a particular outcome. Anticipation and sensation are closely related to each other; human beings still want to gain pleasure and avoid pain. For this reason, anticipation can be considered as: "probabilistic evaluations of sensation in the future" [29]. Moreover, according to [29], users motivated by anticipation are easier to persuade.

  The third core motivator is social cohesion. This motivator can either be social acceptance or rejection. Fogg argues that social dynamics is essential for human beings. Therefore, it is a very powerful motivator for persuasion. People are willing to do a lot for social acceptance, or if it helps them avoid social rejection [29].

- **Simplicity**
  Fogg argues that humans are fundamentally lazy [29]. Therefore, a persuasive technology relies heavily on the power of simplicity. If the target behavior costs too much time or money for the users, it might be difficult to persuade them to reach this behavior. The same applies to too much effort or concentration. Furthermore, if the targeted behavior requires the users to go against social norms, then it is no longer simple for them. Lastly, people seem to find

routines simple. If the targeted behavior is not routine, that could also make it difficult for them to change their behavior.

Even though simplicity is important when it comes to persuasive technology, it is important to remember that target users can have different needs and demands. Therefore, it is crucial to have both the target user and the context in mind when creating persuasive technology [29].

- **Triggers**
  Fogg argues that a trigger is something that tells people to perform a behavior now. They are important in persuasive technology because they can cause people to act on impulse. As mentioned previously, people who act on impulse and do not spend time evaluating are more likely to be persuaded.

  There are three types of triggers: a spark, a facilitator, and a signal. A spark is a trigger that motivates a behavior, and it can leverage any of the motivational elements (i.e. sensation, anticipation or social cohesion). The second is a facilitator, which is a trigger that makes a behavior easier because leverages simplicity. The last trigger is a signal. This trigger works best when the users both have the motivation and the ability to perform the target behavior. It just serves as a reminder. If a user has both the motivation and the ability to change their behavior, then the only thing missing is a trigger that gives the users a kick start to do it.

2.5 Persuasion through Credibility

Credibility is another side of captology that has not yet been discussed. It is relevant due to the importance of the participants belief in the information presented.

Credibility means believability or a perception based on two factors: trustworthiness and expertise [31]. If something or someone is considered trustworthy, they are truthful, unbiased, good and honest. Expertise is defined as experienced, intelligent, powerful and knowledgeable. If one of these two factors are missing, then the systems credibility could be decreased. Unfortunately, that could make persuasion difficult.

According to [32], credibility is especially important when a system acts as a knowledge source, an instructor, or a tutor. Furthermore, it is considered especially relevant when a system report measurements, run simulations, render virtual environments, report on the job performed, or a report a state. Many of these situations are typical for persuasive technology.

According to [33], the most relevant credibility element is design and looks. Also, [34] has investigated the effects of design, and the results show that credible looks can enhance the user's perceptions of trustworthiness. That relates to both the display of the product as well as the interaction experience. It is important that what is presented to the users are realistic and believable for them to be persuaded.

2.6 Five Types of Social Cues that Persuades

A lot has been covered about persuasive technology so far: what it is, how it works, human behavior, motivators, triggers, and credibility. However, how persuasive technology can be a social actor has not been covered thoroughly yet.

As mentioned in section 2.3, persuasive technology can function as a social actor. Furthermore, there are five primary types of social cues that cause people to make inferences about a social presence in a computing product (see Table 2.2). All of them are described below.

Social Cue	**Example**
Physical	Eye- and facial expressions, body language and movement.
Psychological	Preferences, humor, personality, feelings, and empathy.
Language	Interactive language use, spoken language and language recognition.
Social dynamics	Turn taking, cooperation, praise, answering questions and reciprocity
Social roles	Doctor, a teammate, an opponent, a teacher or a pet.

Table 2.2: Five Persuasive Social Cues

1. **Physical Cues that Persuades**
   According to [24], technology can persuade by conveying a social presence. Such persuasion is often done through virtual characters acting like humans. The more realistic presence these virtual characters have; the more powerful the persuasive effect is. They are often used in different computer games because studies have shown that a virtual character that has a supportive and attentive audience might persuade a user to continue playing.

   As mentioned, having physical characteristics are essential while conveying a social presence through virtual characters. Research suggests that the more attractive the character, technology, interface or hardware, the greater the persuasive powers. There is a disagreement about why the attractiveness is so important when it comes to persuasion, but a possible explanation might be a halo effect [1]. Research by [35] shows that it is easier to believe, like or follow attractive people. People tend to think that a good looking person also has other good qualities like intelligence and honesty [36].

   These principals also apply to technology, which means visually pleasing technology is more efficient when it comes to persuasiveness. However, people have different views on attractiveness. Therefore, it is important for designers to understand their users and their opinion on what is attractive [24].

2. **Psychological Cues to Persuade**
   Research indicates that people experienced as similar to us, especially similarities regarding personality, have a greater persuasive effect on us [37]. Therefore, it is important to simulate similarities in persuasive technology [38].

[1] `http://en.wikipedia.org/wiki/Halo_effect`

Fogg argues that a computer system can lead people to think that it has emotions, motivations, intentions or even a personality. It is psychological cues that lead people to believe this. They way a computer system sends out psychological cues can be through simple text messages, "on screen" icons or other messages.

The formulation style of these messages is essential for which kind of personality the users experience the computer to have. Moreover, the computers behavior, in general, could also lead users to think that it has a personality. As an example, if a computer crashes a lot, is slow or hangs, then it could be thought of as difficult and vindictive.

Furthermore, less important similarities can also persuade users; having the same hometown, the same hobbies or interests. The thumb rule is, the greater the similarity, the greater the potential to persuade. That means the product can be persuasive if it matches the personality of the user [24].

The persuasive impact of being a part of the same group or team is enormous. People who believe that they are a group or a team, are more likely to act cooperatively, feel a stronger need to agree with the team's opinion, perceive team messages to be of higher quality. As mentioned, computers can take roles that go beyond being simply a tool.

According to [39], humans can affiliate with a computer as a teammate, and a computer that considered a teammate has a greater persuasive effect. Being on the same team makes the computer seem smarter, more credible and more likable [24]. The more that users can identify with the product, the more likely it will be to persuade to change a behavior [24].

3. **Persuasion through Language**
   Language can be used to persuade, and especially praise and flattery [40]. People tend to believe that flatterers speak the truth. Often they believe that even if the flatterer is insincere. The reason for this is because the flatterer is following the implicit social contract of being sincere.

   Research show that praise from a computer systems can generate a positive effect on people [24]. Computers can praise through dialog boxes that offer congratulations, welcoming messages or messages telling someone they did a good job. Such dialog boxes give the users an impression of having a social presence [41]. Moreover, such dialog boxes usually make the users like the system more. All of this makes the users more open to persuasion. However, too much praising can also take away the personality of the computer. As an example, if the messages feel repetitious, then it might lose the intended persuasive effect.

4. **Persuasion through Social Dynamics**
   There are many unwritten rules and rituals in the society that impacts how people interact with each other. They affect how people feel and can change people's attitudes. The rule of reciprocity is a powerful social dynamic, according to [37]. This rule states that people should help those who helped them, and most human societies subscribe to it.

   The rule of reciprocity can be simulated by a computing system. A computing system experienced as particularly helpful could make the users feel like they need to repay the favor by doing something in return [24]. That opens up the users to be persuaded to change their behavior in a predefined way [42].

   Fogg argues that keeping promises are an important social dynamic for human beings and that dynamic is something computers can simulate. As an example, if there is a voluntary

survey for some user to answer. The response options could be: "yes" or "maybe later". If the user clicks on the "maybe later" button, then they might feel like they made a promise to do it later, which can persuade them to do it.

5. **Persuasion through Social Roles**
   Humans respond differently to different social roles in life. Behavior towards a police officer is, for instance, different from the behavior towards friends. It is dependent on the various social roles.

   In persuasive technology, the targeted behavior is predefined. Having a computer system act as a particular social role might increase the chances of a user developing a specific behavior. However, various target users respond differently to different roles. Therefore, it is important to have a good knowledge of these users to be able to get the targeted behavior [24].

2.7 Persuasive Factors

Frameworks and principles from the previous sections provide useful means for understanding persuasive technology. [43] presents a highlight or a checklist of these principles, and they can be seen in Table 2.3, 2.4, 2.5 and 2.6 below. Each Table represents a specific category, and they are respectively Primary Task Support, Dialogue Support, Credibility Support and Social Support. Within each category, there are seven persuasive factors, and these are the factors that persuade the users to reach a target behavior.

The first category is primary tasks. The persuasive factors in this category are reduction, tunneling, tailoring, Personalization, self-monitoring, simulation, and rehearsal. These are all related to the primary tasks the users carry out while using the system, and also related to the system's structure. An explanation of each factor can be seen in Table 2.3.

Factor	Rationale
Reduction	A system that reduces complex task makes it simpler for the users to reach the targeted behavior.
Tunneling	A system that guides the users through a process and provides them with experience has a greater capability for persuasion.
Tailoring	Information that are tailored to potential needs, interests, and personality, have a greater capability for persuasion.
Personalizing	Offering personalized content (e.g. change the graphical layout), has a greater capability for persuasion.
Self-monitoring	A system that helps to track the user's performance or status has a greater capability for persuasion.
Simulation	A system that let the users observe the link between cause and effect (e.g. before and after pictures of weight loss), has a greater capability for persuasion.
Rehearsal	A systems that let the users rehearse the targeted behavior can enable them to perform it in the real-world as well.

Table 2.3: Primary Task Factors

The second category is dialog support, and the persuasive factors are praise, rewards, reminders, suggestion, similarity, liking and social role. All of them are related to how the system gives feedback, and if the system is suited for the target users. An explanation of each factor can be seen in Table 2.4.

Factor	Rationale
Praise	A systems that use praise can make the users more open to persuasion.
Rewards	A system that uses rewards can make the users more open to persuasion.
Reminders	A system that reminds the users of the targeted behavior during use can make the users more open to persuasion.
Suggestion	A system that offers suggestions (e.g. health app suggests healthier food) can make the users more open to persuasion.
Similarity	If a system reminds the users them of themselves, then this has a greater capability for persuasion.
Liking	Visually attractive systems persuades to a greater extent than systems that are not.
Social role	If a system adapts social roles, then the users will more likely use it for persuasive purposes.

Table 2.4: Dialogue Support Factors

The third category is credibility, and these are the associated factors: trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsement, and verifiability. An expla-

nation of each can be seen in Table 2.5.

Factor	**Rationale**
Trustworthiness	A system viewed as trustworthy, truthful, honest and unbiased has a greater capability for persuasion.
Expertise	A system that incorporates expertise, knowledge, experience and competence increases powers of persuasion.
Surface credibility	A system that has a competent look and feel increases the power of persuasion.
Real-world feel	A system that provides information about the humans behind the system increases the power of persuasion.
Authority	Leveraging roles of authority increases persuasion.
Third-party endorsements	Respected sources increase credibility.
Verifiability	Ability to easily verify content increases persuasion.

Table 2.5: Credibility Factors

The last category is social support, and these are the associated factors: social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition. These are the factors related to the social aspects of the system. Furthermore, an explanation of all of them can be seen in Table 2.6.

Factor	**Rationale**
Social learning	A system that lets the users observe others perform the targeted behavior has a greater capability for persuasion.
Social comparison	A system that lets the users compare results with other users has a greater capability for persuasion.
Normative influence	A system that uses peer pressure to gather the users to have the same goals and norms increases the systems power of persuasion.
Social facilitation	A system that motivates its users by discerning other who are performing the behavior increases the chances of persuasion.
Cooperation	A system that motivates its users by leveraging cooperation with other users increases the chances of persuasion.
Competition	A system that drives its users by leveraging competition has a greater capability for persuasion.
Recognition	A system that provides public recognition to those who perform the targeted behavior increases the chances of persuasion.

Table 2.6: Social Support Factors

2.8 Designing Persuasive Technologies

According to [30], it is more challenging to design for persuasive purposes compared to usability. There are many that fail and the main problem is often that the projects are too ambitious. Therefore, [30] came up with an eight-step design process to increase the odds of success:

1. **Choose a simple behavior to target:**
   The first step is to select an appropriate behavior to target for change. The designers should choose a simple behavior that matters. It often requires some time to reduce the goal.

2. **Choose a receptive audience:**
   The next step is to choose the right audience. There are many things to worry about when creating a new persuasive technology, and a resistant audience is not helpful.

3. **Find what prevents the target behavior:**
   In this step, the goal is to determine what is preventing the audience from performing the target behavior. Is it lack of motivation? Lack of ability? Or is it lack of a trigger?

4. **Choose a familiar technology channel:**
   The next step is selecting a technology channel that is familiar to the target user. [30] states that were expecting an audience to learn a new channel and simultaneously adopt a new behavior decreases chances of behavior change.

5. **Find relevant examples of persuasive technology:**
   In this step, the goal is to find examples of persuasive technology solutions that succeed before.

6. **Imitate successful examples:**
   The next step in the persuasive design process is to imitate what's working in the successful examples gathered in the step above.

7. **Test and iterate quickly:**
   After finding a way to imitate successful examples of persuasive technology, the next step is to test various persuasive experiences quickly and repeatedly. A series of small, rapid tests will teach more than one big test.

8. **Expand on success:**
   Creating a persuasive technology that changes a behavior, no matter how small or simple, is a milestone. In this step, the goal is to expand on the success and scale up. One possibility is to make the target behavior more difficult, but there are many ways to do it. No matter how it is scaled up, the expansion should be systematic.

3 | Virtual Reality

This chapter discusses the definitions of virtual reality or VR. It also describes related factors like presence, immersion, realism, engagement and involvement. The last section discusses how to measure presence.

3.1 Virtual Reality Definition

There exist several definitions of virtual reality. However, defining it is not an easy task due to the challenge of explaining something to be real and virtual at simultaneously. Virtual is defined as being in essence, but not in fact [2]. Reality, on the other hand, is a complicated philosophical discussion [3].

According to [3], the virtual reality term was first used in 1989 by Jaron Lanier, and since then there have been many different definitions. [44] defines it as *" electronic simulations of environments experiences via a head mounted eye goggles and wired clothing enabling the end user to interact in realistic three-dimensional situations."* Furthermore, [45] refers to a different definition: *"Virtual reality is an alternative world filled with computer generated images that respond to human movements. These simulated environments are usually visited with the aid of an expensive data suit that features stereophonic video goggles and fiber-optic data gloves."* When comparing these two definitions, it is possible to see that [45] moved further away from the hardware terms.

Additionally, [45] casted new variables: *"A virtual reality is defined as a real or simulated environment in which a perceiver experiences telepresence."* Similarly, [46] defines VR as *" an experience as any in which the user is effectively immersed in a responsive virtual world. This implies a user dynamic control of viewpoint."* Such terms (i.e. telepresence, presence and immersion) are also used today, due to the possibility to classify virtual reality in relation to other medias. It is possible to read more about these variables in Section 3.2.

A more recent definition of virtual reality is, and the one used in this research project is: *" a medium composed of interactive computer simulations that sense the participant's position and actions, providing synthetic feedback to one or more senses, giving the feeling of being immersed or being present in the simulation."* [8].

Furthermore, [46] discusses four technologies essential for a virtual reality. The first is the visual display that immerse the user in the virtual world. Moreover, a display that block out the contradictory sensory impressions from the real world. The second is the graphic rendering system that

generates the frames. The third is the tracking system that continuously reports the position and orientation of the users head.The fourth is the database construction and maintenance system for building and maintaining detailed and realistic models of the world. Lastly, [46] mentions many applications for virtual reality: vehicle simulations, entertainment, vehicle design, architectural design, training for emergencies and psychiatric treatment.

3.2 Presence

According to [45], [47], [48] the key to defining virtual reality in term of human experience rather than technological hardware is through the concept of presence. It is possible to see an illustration of the presence in Figure 3.1.

[45] defines presence as *"the sense of being there"*. Also [6] links the effectiveness of virtual environment to the sense of presence: *"the subjective experience of being in one place or an environment, even when physically situated in another"*. Similarly, [3] defines presence to be equivalent to mental immersion, which is the feeling of being there.

It is evident that there exist several definitions of the term. Unfortunately, "presence" has no standard recognized definition. On the other hand, most of the literature proposes something similar to the following: *"Presence is the subjective experience of being in one place or an environment, even when one is physically situated in another place or environment,"* which is used throughout this research project.

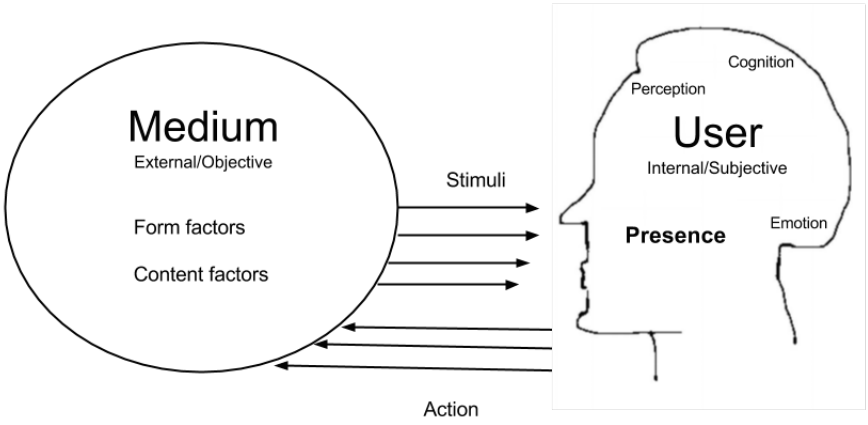


Figure 3.1: Presence

[49] argues that the experience of presence may have aspects similar to the concept of selective attention. Furthermore, that someone's attention is guided by the meaningfulness of the information presented. Similarly, [6] states that: *" Presence is an awareness phenomenon that requires directed attention. It is based on the interaction between sensory stimulation, environmental factors that encourage involvement, enables immersion, and internal tendencies to become involved in the*

environment". [6] believes that humans experience varying degrees of presence in a physical locale. Typically attention is divided between this physical world and the mental world of memories, daydreams and planned activities. How sharply users focus their attention on the virtual environment partially determines the extent to which they will become involved in that environment, and how much presence they will report.

Lastly, there are several factors that affect presence. More explicitly, to which extent a user feels present in a virtual environment. [6] listed some factors that influence the experience of presence. These are used as a basis for this research project, and they can be seen in Table 3.1, 3.2, 3.3 and 3.4.

Control Factors	**Rationale**
Degree of control	The more control a person has over the task environment or in interacting with it, the greater the experience of presence.
Immediacy of control	When a person acts in a VE, the consequences of that action should be appropriately apparent to the actor to increase presence.
Anticipation of events	Individuals will probably experience a greater sense of presence in a VE if they can anticipate what might happen next.
Mode of control	Presence may be increased if the manner in which one interacts with a VE is a natural or a well-practiced method.
Physical environment modifiability	Presence should increase as if the users ability to modify physical objects in that environment increases.

Table 3.1: Control Factors

Sensory Factors	**Rationale**
Sensory modality	A hierarchy of modalities may influence how much presence is experienced. Especially visual information strongly affects presence.
Environment richness	The sense of presence will increase if the extent of sensory information transmitted to appropriate sensors of the observer also increases.
Multimodal presentation	The more completely and coherently all the senses are stimulated, the greater the experience of presence should be.
Consistency of multimodal information	The information received through all modalities should describe the same objective world.
Degree of movement perception	Presence can be enhanced if the users perceive self-movement through the VE, and to the extent that objects appear to move relative to the observer.
Active search	An environment should increase presence when it permits the users to control the relation of their sensors to the environment.

Table 3.2: Sensory Factors

Distraction Factors	Rationale
Isolation	Devices that isolate users from their actual, physical environment may increase presence in a VE.
Selective attention	The user's willingness or ability to focus on the VE stimuli and to ignore distractions that are external to the VE should increase the amount of presence experienced.
Interface awareness	If unnatural, clumsy, artifact-laden interface devices interferes with the direct interpretation of, or interaction with, a VE, that can decrease the experience of presence.

Table 3.3: Distraction Factors

Realism Factors	Rationale
Scene realism	Presence should increase as with the scene realism, which is managed by the scene content, textures, resolution, light sources and dimensionality. However, real-world content is not required, but rather consistency and continuity with what is being presented.
Information consistent with objective world	The more consistent the information conveyed by a VE compared with the real-world experience, the more presence should be experienced.
Meaningfulness of experience	Presence should increase as the situation presented becomes more meaningful to the person.
Separation anxiety/disorientation	The users may experience disorientation or anxiety when returning from the VE to the real world. The amount of this disorientation may increase if the presence experienced in the VE increases.

Table 3.4: Realism Factors

3.3 Immersion

The terms presence and immersion are seen together relatively often. Additionally, both very loosely defined. Since the presence has already been covered. This section explains the term immersion.

According to, [3] immersion is: *" the feeling of being involved in the experience"*. However, According to [50], one of the most accepted definitions of immersion is Janet Murray's [51]:

"A stirring narrative in any medium can be experienced as a virtual reality because our brains are programmed to tune into stories with an intensity that can obliterate the world around us. . . . The experience of being transported to an elaborately simulated place is pleasurable in itself, regardless of the fantasy content. We refer to this experience as immersion. Immersion is a metaphorical term derived from the physical experience of being submerged in water. We seek the same feeling from a psychologically immersive experience that we do from a plunge in the ocean or swimming pool: the sensation of being surrounded by a completely other reality, as different as water is from air, that takes over all of our attention, our whole perceptual apparatus . . . in a participatory medium,

immersion implies learning to swim, to do the things that the new environment makes possible . . . the enjoyment of immersion as a participatory activity."

[6], also uses the term immersion regarding virtual reality: *A psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences."* Moreover, according to [6], immersing people in a simulated environment is what virtual environment are designed to do. Moreover, a virtual environment that increases the sense of immersion, also increases the sense of presence.

There are several factors that affect immersion [52]. The first is isolation from the physical environment. The second is a perception of self-inclusion in the virtual environment. The third is natural modes of interaction and control, and lastly, a perception of self-movement.

In summary, it is evident that presence and immersion are essential aspects of virtual reality (see Figure 3.2). In this research project, presence is the users subjective feeling of being there, and immersion is the degree of how involved the users get. Lastly, immersion increases the users experience of presence.

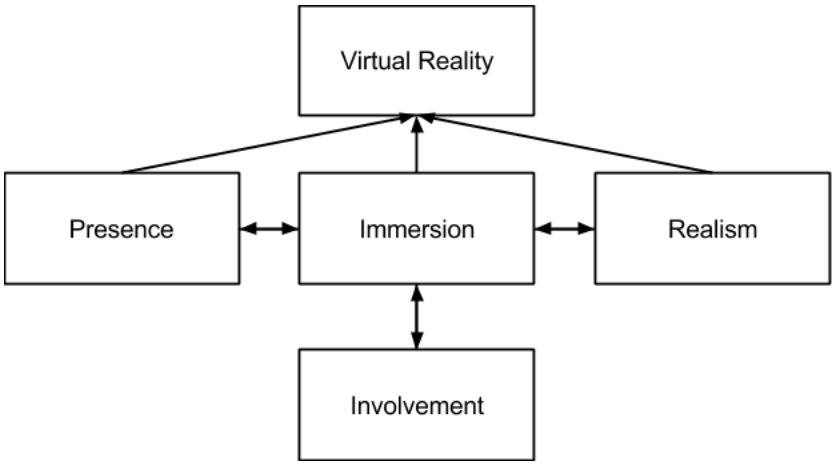


Figure 3.2: Factors Connected to VR

3.4 Involvement and Engagement

According to [6], involvement is *"a psychological state that is experienced as a consequence of focusing one's energy and attention on a coherent set of stimuli or meaningfully related activities and events."* Involvement depends on the degree of significance or meaning an individual attaches to the stimuli, activities, or events. The more focus and attention a user give the VR, the more involved they become in it. Consequently, this leads to an increased sense of presence and immersion.

3.5 Realism

Realism is concerned with how accurately a virtual reality represents objects, events, and people. It is divided into social realism and perceptual realism [50]. Perceptual realism refers to a presence experience where the mediated representation accurately simulates or reproduces the sensory experience that would be expected in the non-mediated context. Social realism describes a presence experience where the behavior and language of the social actors in the virtual environment are true to life or realistic in nature.

3.6 Measuring Presence

When it comes to measuring the experience of presence and immersion, there are some disagreements whether presence and immersion are a subjective sensation or if it is objectively measurable properties from the system itself.

According to [47], presence is a subjective sensation, which is not easily amenable to objective physiological definition and measurement. However, [47] does not dismiss objective measures of presence. On the other hand, [53] considers presence to be an objective description of the virtual environment technology. There is also a third research [6], which believes the degree of presence experienced is both a function of individual differences and the characteristics of the environment. They think that individual differences and abilities may enhance or detract from the presence experienced, but they also believe that various features of the virtual reality may increase or reduce the experience of presence.

Many approaches have been used to measure presence [54]: measuring heart rate, blood flow, eye reactions and skin temperatures. There have also been studies using pattern recognition's for facial expressions to measure presence. However, the most common approach is using a subjective presence questionnaire. The scope of the questionnaires depends on their definition. Some focus on technological characteristics (i.e. perceptual or physiological responses to those characteristics). Others focus more on more cognitive issues.

[6] made one of the first structural presence questionnaires. It was formulated according to all the factors they connected to the experience of presence (see Section 3.2). Furthermore, they argue that a valid measure of presence should address the factors that influence involvement, as well as those that affect immersion. For this reason, they developed two questionnaires: one presence questionnaire (PQ) and one immersive tendency questionnaire (ITQ). The PQ measured the degree to which individuals experienced presence in a virtual reality, and the influence of factors contributing to the intensity. The ITQ was designed to measure individuals capability to be immersed.

During the past decade, nearly 70 different measures and over a 100 experimental studies related to presence are identified. There is even a compendium [54] that summarizes all the methods for measuring the experience of presence, and it contains both subjective and objective methods. Unfortunately, there is no standard methodology for measuring presence today. There is, however, some evidence that particular technological tasks and personal characteristics can influence the degree of presence experienced.

For this research project, a subjective presence questionnaire will be created. Even though there are no standard methods to measure presence, it will be created based on topics and questions from existing questionnaires. Furthermore, it will be based on all the factors that research claims increases presence. In addition, it will be modified to fit for this specific traffic accident simulation created. Lastly, it will be based on criteria identified by [55] of how a presence questionnaire ideally should be. The criteria are listed below.

- **Understanding of presence should not be assumed by asking respondents directly how present they feel.**
- **Questions should avoid addressing two issues in one question.**
- **Response options should ideally be consistent across items.**
- **Presence is likely to be a multidimensional construct, and therefore questionnaires should reflect this and tap a range of characteristics.**
- **Questions should not make reference to specific media system and content properties.**
- **A general presence measure should be piloted on participants of a range of media systems/contents.**
- **Questionnaires should be piloted with a sufficient number of subjects.**

3.7 Simulation Sickness

During a simulation, a person might feel sick, and the reason might be simulation sickness. Simulation sickness is based on the theory of cue conflict. A cue conflict occurs when there is a disparity between senses or with a sense. The two primary conflicts is thought to be at the root of simulator sickness occur between the visual and vestibular senses. That means that the visual system detects motion, while the vestibular system senses no motion [7].

According to [7], simulator sickness is similar to motion sickness. However, they are not the same. With motion sickness, a person is being subjected to movements with particular characteristics that gives uncomfortable symptoms. Simulation sickness, however, can occur without the actual movement. The reason the users feel uncomfortable is due to visual stimulation inducing the symptoms. Currently, no single factor is identified as the cause. Instead, there are several factors involved.

The typical symptoms of simulation sickness are general discomfort, apathy, drowsiness, headache, disorientation, fatigue, pallor, sweating, salivation, stomach awareness, nausea, and vomiting. These symptoms are similar to the symptoms of motion sickness.

[6] studied the correlation between presence and simulation sickness. They found significant negative correlations between the simulation sickness questionnaire and the presence questionnaire. They argue that the symptoms associated with simulation sickness draw attention away from the virtual environment and thereby reducing the sense of presence.

4 | Virtual Reality and Persuasion

This chapter connects persuasive technology to virtual reality. It discusses how virtual reality can be used to persuade a user to change an attitude or behavior. Furthermore, it connects the link between presence and a user's emotions. Lastly, it connects presence and persuasion.

4.1 Effects of Simulated Human Distress on Attitudes

Virtual reality is a powerful media that allows the users to experience the effects of actions in a vivid and memorable way. However, there are relatively little research conducted on using virtual reality as a persuasive technology. The literature from Chapter 2 focused mainly on non-VR approaches. Additionally, the VR community explores several aspects of the technology but omits the relation to persuasion [12].

However, some research has been conducted. [12] did a research project where the goal was to persuade users to avoid walking into smoke during building evacuations caused by fire. The theory was that a VR simulation could persuade by enabling the users to observe the link between cause and effect in an emotional and memorable way. More specifically, the research focused on virtual realities' natural delivery of various forms of negative and positive feedback to the users based on their actions done.

Furthermore, they explored humans memorization of feedback because according to [56] people are more likely to store positive information when in a positive mood, and negative information when in a negative mood. Additionally, [57] argues that emotion plays an essential role when it comes to risk perception, and especially with negative emotion heightening the perception of risk. Also, according to [58], the perception of risk as feelings, and not as a rational analysis, is widespread in individuals and the way the form their attitudes because it becomes instinctive and intuitive. Therefore, [12] created a simulation that produced a negative effect when the user walked into the smoke.

Furthermore, studies that uses negative messages that appeal to fear and results in anxiety have shown that mild fear is an effective strategy when it comes to persuasion [58]. However, greater levels of anxiety can result in less persuasion because it triggers defensive reactions. Therefore, the negative effect was tunnel vision and red flashed every time the users walked into smoke, and the targeted behavior was not to walk into smoke during an evacuation.

The results of the research indicated that it was possible to use VR for persuasion. The experiment

showed that virtual reality that focus on emotional intensity feedback to the users can be an effective when it comes to persuasion.

4.2 The Link between Presence and Emotions

Emotions are present in almost all events in our life. However, there still lacks research in this area. Especially research regarding feelings induced by mediated experiences. According to [59], movies have been effective when it comes to inducing emotional, behavioral and physiological responses coherent with the contexts of the movie being viewed. Furthermore, [59] argues that this is also possible for advanced interactive media such as VR. They found that virtual parks were able to induce an expected emotional state. Furthermore, they explored the link between presence and emotion, and they concluded that the relationship was influenced by the overall characteristics of the virtual reality experience. These results show that VR is an efficient mood induction media.

4.3 Connecting Presence and Persuasion

According to [13], a VR experience creating presence can simulate a real sense of "seeing" a product. This leads to a stronger sense of believing in the in the information embedded in the mediated communication. Their finding suggests that when the users feel present in a virtual environment, they are also more likely to be persuaded. Additionally, research by [60] argues that the sense of presence may be the mediating variable that has not been adequately measured in previous studies on the relationship between “vividness” and persuasion.

Other research also supports the effect presence has on persuasion [61], [62] and [63]. These studies found that direct, first-hand experience of participating in psychological experiments, or simply sitting before a live communicator gives a person an opportunity to infer an attitude from the experience. Thus he/she can hold that attitude with greater confidence. When someone experiences presence, it is assumed that they are more likely to consider their experience in the mediated environment as first-hand, or direct. Therefore, as with direct experience, the sense of presence is expected to have a positive effect on behavior change.

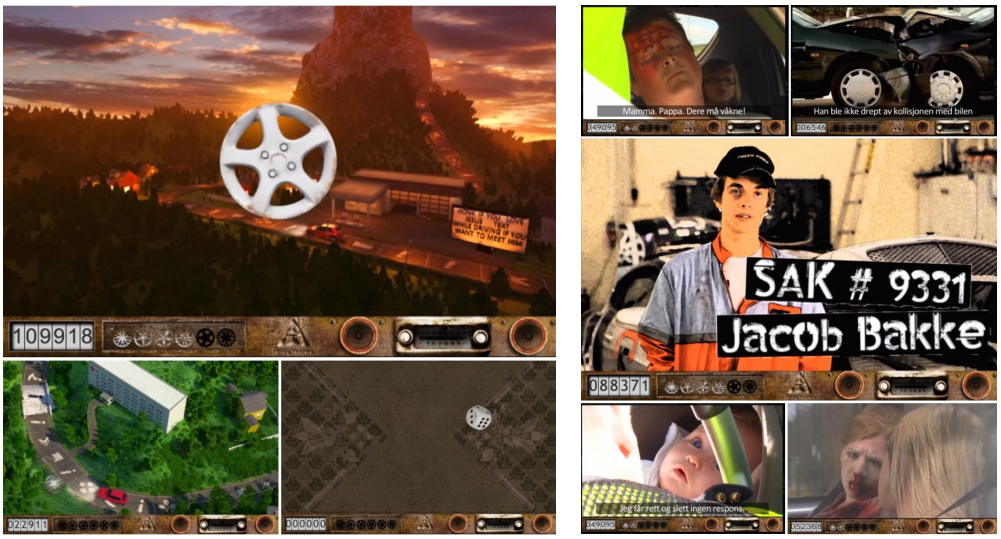
5 | Persuasive Traffic Safety Medias

This chapter describes existing medias created with the purpose of persuading the target users to avoid risky behavior in traffic. The first Section describes the computer game, Real Life Auto, developed by Trygg Trafikk. The second section discusses campaign videos. Additionally, there is a description of the campaign video used in this research project.

5.1 Computer Games - Real Life Auto

According to Trygg Trafikk [10], around 60 Norwegian adolescents perish in traffic accidents every year. The causes are usually: driving under the influence of alcohol, speeding, not wearing a seat belt or inattentiveness. Therefore, Trygg Trafikk developed an online traffic safety game called Real Life Auto. The intention was to educate and create awareness about traffic safety and to change their risky behaviors in traffic.

Real Life Auto has the looks of a virtual board game. The game piece is a red car, and it is driving around in a little neighborhood. The goal in the game is to get the car from start to finish. The users throw a dice that moves the car forward, and in between there are videos, facts, quizzes, and additional exercises. Screenshots from the game can be seen in Figure 5.1.



(a) Real Life Auto Layout (b) Real Life Auto Videos

Figure 5.1: Real Life Auto

In the preliminary research project, an experiment was conducted on a group of target users. The purpose was to evaluate the persuasiveness of RLA. The experiment had two main parts. The first part was a usability test, due to the strong relation between usability and persuasive technology. If the users are not able to use a system, it would be challenging to use it as a tool for persuasion. In the second part of the experiment, the users evaluated the systems ability to change attitude, behavior, and perception. Additionally, they evaluated several factors that the literature claims has a positive effect on persuasion. Both quantitative and qualitative methods were used to gather the data. However, the result from the analysis of the data indicated that RLA did not have the desired persuasive effect on the target users.

The results indicated that the target users did not consider Real Life Auto to cause a vital change in attitude, behavior or perception. However, they felt some of the videos were impactful. Therefore, a slight attitude change was imaginable. Additionally, the participants evaluated eleven persuasive factors that appeared in RLA. Among them, the only factors that had a significant positive impact on persuasion were "trustworthiness and expertise". Furthermore, five of the factors (i.e. personalization, self-monitoring, rewards liking, surface credibility) was considered to have an adverse influence. The qualitative results indicated that the game was too childish, both the looks and the content. Furthermore, they felt like the game was extremely long.

The conclusion of the preliminary research was to either create a new version of the game or to develop an entirely new game. Many of the participant's even mentioned that they did not think adolescents would change until they experienced a traffic accident for themselves. However, this research investigates how impactful Real Life Auto is compared to other medias created for persuasive purposes (i.e. persuading the target users to avoid risky behavior in traffic).

5.2 Campaign Videos

As mentioned previously, adolescents are significantly over-represented in traffic accidents. Furthermore, traffic accidents are an enormous threat to the public health. Traffic safety campaign videos (i.e. a video promoting a safe driving behavior) were created to cope with this problem.

In was done because [64] researched risk perception and driving behavior among adolescents before and after a traffic safety campaign in Norway. Moreover, it was campaign videos focusing on producing an emotional reaction. The research concluded that risk perception related to speeding or other traffic hazards had changed significantly after watching the campaign videos. Additionally, the number of speeding accidents were reduced by 13%. In the control group (i.e. had not watched the videos), the perceived risk had not changed. Furthermore, the research showed that the more worried and emotional the respondents were, the less risky behavior in traffic afterward.

However, relatively little research has been conducted on the subject recently. Further, there is also relatively little research comparing medias with an intent to change risky behavior in traffic.

5.2.1 Highway to Hell

The campaign video shown to the target users in this research project was made in the United Kingdom by the Lyle Bailie International Agency in 2007. The name of the video is "Highway to Hell", and the song used in the video is "I can't take my eyes off you" by Avrutin Ft Charlie James.

The video starts with a couple that hangs out on a brick wall, and they seem quite in love. In the next second a traffic accident occurs. One of the involved cars comes straight towards the couple, and two of the other cars involved crashes in each other (see Figure 5.2).

Figure 5.2: Highway to Hell - The Beginning

The car that comes towards the couple ends up crashing into them, and they end up stuck in-between the vehicle and the brick wall. The situation is also critical for the people in the other impact: one car driver is severely injured, and her passenger has perished. Furthermore, on the sidewalk there was a little girl playing with her dolls. Unfortunately, she becomes a witness to the tragic accident, which can be seen in Figure 5.3.

Figure 5.3: Highway to Hell - The Impact

In the next scene, help has arrived. A rescue team strives to get the boy and the girl loose. At this point, it is unclear if the boy is unconscious or dead. However, judging from the look of the girl, it seems like the latter. Another rescue team helps the injured driver. They also cover up the perished passenger. In the middle of these two scenes walks a scared and upset, but not injured boy. He was the driver that caused the accident. It is possible to see this in Figure 5.4.

Figure 5.4: Highway to Hell - The Rescue Team

The next scene happens at the hospital. The boy previously stuck between the brick wall and the car gets taken off life support. His parent are crushed. In another hospital bed lies the girlfriend, and she is barely alive. Her parents stand next to her hospital bed comforting each other. It is possible to see this in Figure 5.5.

Figure 5.5: Highway to Hell - The Hospital

Towards the end of the campaign video, there is a trial. The judge has a clear message for the

driver that caused the accident: "You were simply driving too fast to cope with the unexpected." In the audience sits several people that were affected by the disaster.

Seconds later, it is shown what caused the accident. The driver tried to pass another car, but suddenly he spotted a dog on the road. He attempted to avoid it, but that ended up causing the accident. It is possible to see this in Figure 5.6.

Figure 5.6: Highway to Hell - The Trial

The end of the campaign video shows the girlfriend in a wheelchair sitting next to the grave of her dead boyfriend. Lastly, the camera zooms out over the entire graveyard, with the text: "The faster the speed the bigger the mess." It is possible to see a screenshot of this in Figure 5.7.

Figure 5.7: Highway to Hell - The Ending

6 | Technologies

This section describes and explains the Oculus Rift, OR. It also describes the technologies and frameworks used for developing an Oculus Rift simulation of a traffic accident.

6.1 Oculus Rift

The Oculus Rift is a virtual reality headset, or a head-mounted display, which lets players step into games or a virtual world. It was developed by Oculus VR, and founded as a Kickstarter project in August 2012. The Rifts are Development Kits and are still in Beta testing. It is possible to see the Oculus Rift in Figure 6.1.

The OR uses custom tracking technology to provide ultra-low latency 360 degrees head tracking. This head tracking allows the user to look seamlessly around the virtual world. Every movement of the user's head is tracked in real time, which creates a natural and intuitive experience. Furthermore, it has a stereoscopic 3D view depth, scale, and parallax. The Oculus Rift presents unique and parallel images for each eye, which the same as users real eyes perceive images in the real world. That also creates a much more natural and comfortable experience.

The Oculus Rift DK2, which can be seen in Figure 6.1(a) is the latest development kit. This development kit comes with positional tracking. The positional tracking is low-latency, this technology allows mapping the users real head movements. The sensor can be seen in Figure 6.1(b).

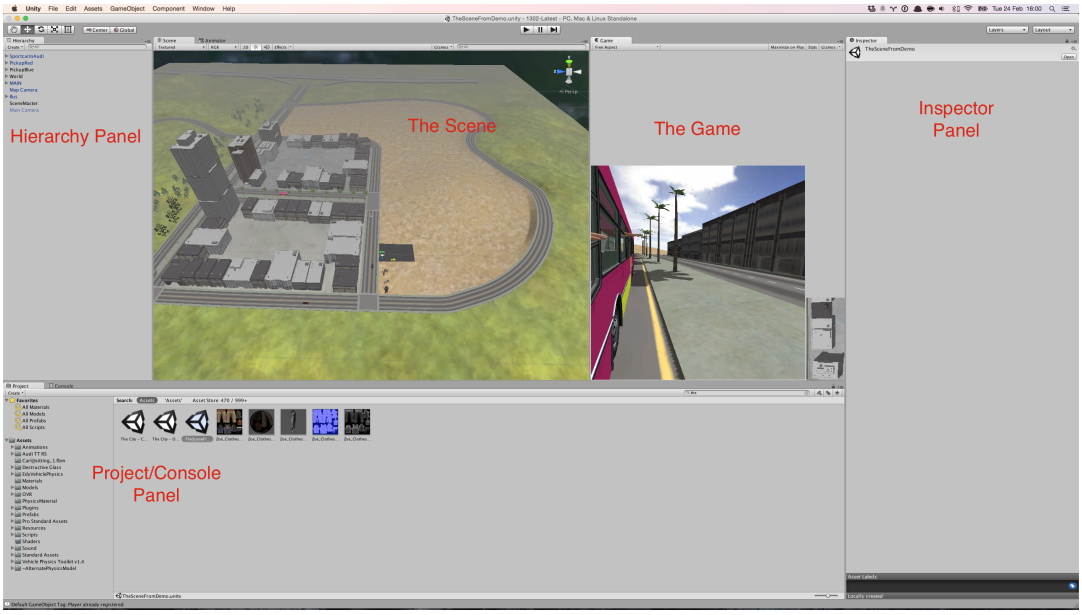
(a) Oculus Rift DK2

(b) The Oculus Sensor

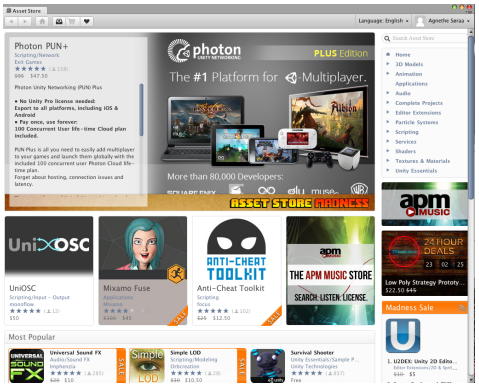
Figure 6.1: The Oculus Rift - Images from Oculus.com

6.2 Unity 3D and MonoDevelop

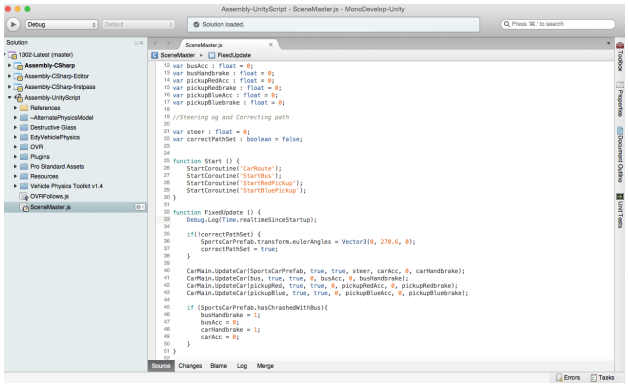
Unity is a fully integrated development engine for developing multiplatform games and interactive content. With Unity, it is possible to assemble art and assets into scenes and environment. The Unity application is a complete 3D environment, suitable for laying out levels, creating menus, doing animation, writing scripts, and organizing projects. The user interface is structured and organized with panels that can be fully customized by "drag and drop". Furthermore, the workspace is intuitive, and it has a large variety of different tools (e.g.lighting, audio, special effects, physics, animation). Moreover, after developing a game, it is possible to publish the game for a variety of different platforms. These are platforms such as Mac, PC and Linux desktop computers, Windows Store the Web, iOS, Android, Windows Phone 8, Blackberry 10, Wii U, PS3 Xbox 360, and Oculus Rift.



(a) Unity



(b) Asset Store Unity



(c) MonoDevelop

Figure 6.2: Screenshots Unity

In Unity, there are six main panels: Project panel, Scene panel, Game panel, Hierarchy panel, Inspector panel and the console, which can be seen in Figure 6.2(a). The Project panel is where all the assets of a project are stored (e.g. 3D models, car models, skyboxes). The Scene panel is a 3D viewpoint where it is possible to arrange assets by physically moving them around in the 3D space. In the Scene panel, it is possible to navigate the viewpoint by panning, rotating, and zooming the view. The game panel plays the actual game when the play button is hit. The Hierarchy panel is where the assets from the scene are organized. Assets from the Project panel can be dragged into the Hierarchy panel, in order to add them to the current scene. The Inspector panel gives the

opportunity to adjust all the different attributes of some selected asset such as position, rotation, gravity or able to cast a shadow. Lastly, the console can be used for debugging.

Unity also has an Asset Store, which can be seen in Figure 6.2(b). At the asset store, it is possible to buy projects, animations, 3D models, and additional assets previously developed and published for sale. There are also some free assets.

In Unity, scripts are known as behaviors. Through scripts, it is possible to make the assets in a scene interactive, and it is done by adding scripts to game object in the scene. Unity supports three different programming languages. The first is UnityScript, which is very similar to JavaScript. The second script is C#, and lastly, Boo, which is similar to Python.

The integrated development environment, IDE, for writing code is called MonoDevelop. Unity Synchronizes the script from MonoDevelop. It is possible to see a screenshot of MonoDevelop in Figure 6.2(c).

6.3 EDY's Vehicle Physics

Edy's Vehicle Physics was used in this research project. It is a car physics package from Asset Store (see Figure 6.2(b)). This asset provides 3D car models with a complete car physics implementation. It includes several different 3D models of cars, advanced audio effects, other effects like skid marks and smoke, vehicle damage, and it has realistic car physics. Edy's vehicle physics has a fully working demo scene, as well as being thoroughly documented.

Furthermore, Edy's Vehicle Physics comes with several scripts. However, this section only describes the most relevant for this research project. The first is two scripts are related to cameras, and they are CameraControl and CarCameras. CameraControl controls the main camera of the scene and provides different views and camera options, and the CarCameras script controls manage the vehicle-specific camera settings, including mirror cameras, vehicle cameras and view parameters.

The next scripts are related to the vehicle's behavior. The CarControl script is the main script for controlling and configuring each vehicle's behavior and handling, and the CarMain script handles the user input and the logic of the scene. There is also a script called CarSettings which holds high-level properties for configuring each vehicle's features and driving aids. Moreover, there is a CarWheel script that controls the WheelCollider component for behaving as expected. A WheelCollider is a unique collider for vehicles that has a built in collision detection and general wheel physics. In order to gather information regarding the WheelColliders's friction curve, there is also a CarWheelFriction script.

Edy's Vehicle Physics also has scripts that handle car damage and the visuals of the car. The CarDamage script performs the mesh deformation if there is an impact, and the CarVisuals creates the visual effects for the wheels. Lastly, this car physics package also has scripts for sound and sound control.

Part III

Research Methods and Research Design

7 | Research Methods

This chapter gives an overview of the research methods used in this research project. However, the details of the specific design are presented in Chapter 9.

7.1 Quantitative Vs. Qualitative Research Methods

This research project will use a combination of both qualitative and quantitative research methods, which according to [65] are the two main research paradigms. The following subsections will describe both qualitative and quantitative research methods.

7.1.1 Qualitative Research

Qualitative research is the study of objects in their natural environment to get a better understanding of a case. It is a research paradigm that seeks a deeper understanding of a social phenomena (e.g. human behavior) [66]. The researcher often starts the study with a neutral and open view on the phenomena. The goal is to allow a theory or context to be revealed by analyzing the data collected [67]. In qualitative research the data collection methods are typically interviews, questionnaires, documents or participant observations, and the research methods are action research, case studies, and ethnographical studies. The motivation for using qualitative research compared to quantitative research is for the researcher to get a better understanding of a phenomenon from the target population's point of view. According to [68] the goal is to seek new insights, ask questions, assess phenomena in a new light, or generate ideas for future work.

7.1.2 Quantitative Research

According to [69], quantitative data means data or evidence based on numbers. It is the main type of data generated by experiments and surveys [66]. However, it can be collected by other research strategies as well. The idea of the analysis is to look for patterns in the data and draw conclusions. Furthermore, it focuses on statistical results, and trying to find statistically significant relationships, or comparing two or more groups.

7.2 Usability Testing

Usability, user-friendliness, and user experience are terms used regarding websites, computer programs or other computing systems. A system that is understandable and easy to use is essential. ISO 9241-11 standard [70] defines usability as:

- **Usability:**
  The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use.
- **Effectiveness:**
  Accuracy and completeness with which users achieve specified goals (e.g. how many tasks the user completed).
- **Efficiency:**
  Resources expended in relation to the accuracy and completeness with which users achieve goals (e.g. time measured on tasks or the number of mouse clicks).
- **Satisfaction:**
  Freedom from discomfort, and positive attitudes towards the use of the product (e.g. interview and questionnaires about the individual attitude towards using the product).
- **Context of Use:**
  Users, tasks, equipment (hardware, software, and materials), and the physical and social environments, in which the product is used.

Usability testing is one method available for evaluating the ease of learning and use of products. During the test end users perform planned tasks on the product or system being tested, usually while thinking aloud. The data from this test are often recorded and analyzed, and the results are usually used to make proper improvements in order to make the product more user-friendly. A typical execution of a usability test is described below [71].

7.2.1 Guidelines for Usability test

There are several things to remember during a usability test. Therefore, [72] provides a ten step guideline for developers and researchers to keep track of everything while facilitating a usability test.

1. Introduce yourself and the other facilitators of the usability test.
2. Explain the purpose of the test and specify that it is the product that is being tested, and not the participant.
3. Inform the participant that the participant, without any further explanation, can abort the test at any time.
4. Describe the technical equipment in the usability lab, as well as the limitations of the prototype being tested.

5. Teach the participant how to think aloud to get an insight into the participants thoughts.
6. Explain that you will not be able to give the participant help during the test.
7. Describe the task given to the participant and introduce the product being tested.
8. Ask if the participant has any questions about the task before conducting the actual test.
9. Wrap up the test by letting the user comment on the product.
10. Use the results.

7.3 Prototyping

According to [73], "prototypes" are representations of a design made before final artifacts or system exist, and they are created to inform both design process and design decisions. Prototyping is the key activity in the design of artifacts or systems.

There exists many prototyping techniques: storyboards [74], scenarios [75], sketches [76], video, or step through simulations. A prototype adds value by communicating elements that make up an experience about a product.

[73] define the term experience prototype: *"to emphasize the experiential aspect of whatever representations are needed to successfully (re)live or convey an experience with a product, space or system."* This definition means that an experience prototype can be any media as long as it is designed to understand or experience what it might be like to engage with a product, space or system.

Previously, prototypes have been defined with different levels of fidelity [77]. However, [76], discuss various functions for prototypes as being essentially about the "role" an artifact will play, its "look and feel" and how it will be implemented. They created a three-dimensional space that corresponded to these important aspects (see Figure 7.1). The role refers to questions about the functions that an artifact serves, which means the way in which it is useful to a user. Look and feel refers to questions about the concrete sensory experience. Lastly, implementation refers to questions about the techniques and components, which means how it actually works. [76] states that no dimension is inherently more important than any other.

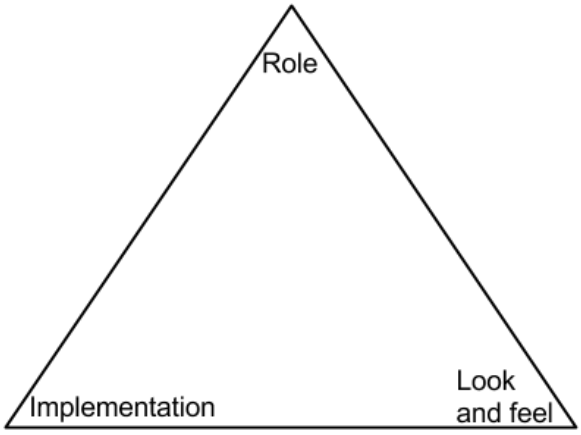


Figure 7.1: Prototyping

In this research project a prototype of a traffic accident simulation for Oculus Rift was created. It was meant to give an experience or an understanding of how a fully implemented simulation in Oculus Rift could be like. In the three-dimensional space, the simulation is placed in the middle because it is a combination of all three dimensions (see Figure 7.2). It is a look and feel prototype because it is meant to demonstrate a concrete experience. It is also a role prototype because it shows what the target role might be. In addition, it shows the functionalities. Lastly, it is also an implementation prototype because it answers many technical questions about how to build a fully implemented simulation.

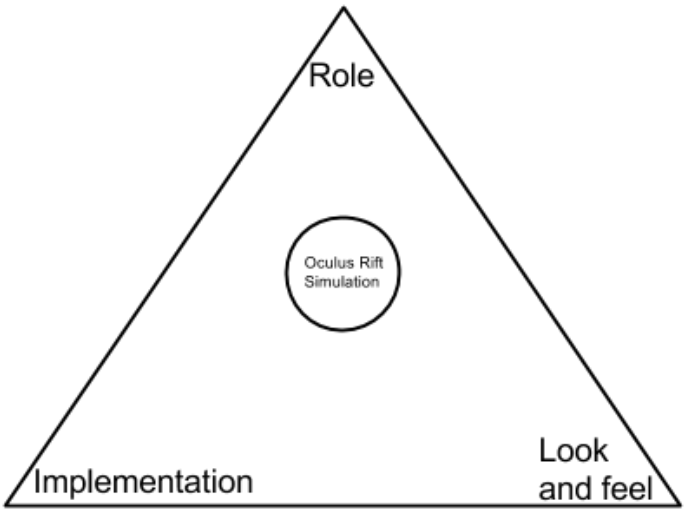


Figure 7.2: Prototyping the Simulation

Additionally, this simulation was a scenario-based prototype [78] because scenario based prototypes

follow a realistic scenario of how the system would be in a real-world setting. Scenarios are stories describing a sequence of events, which is what the traffic accident simulation does. It is possible to read the details about the prototype in Chapter 10.

7.4 Questionnaires

[69] defines a questionnaire as a pre-defined set of questions, assembled in a pre-defined order, which respondents are asked to answer. The answers provide a large amount of data that can be analyzed and interpreted (e.g. patterns and make generalizations). Due to the large amount of data, they are often used in quantitative research. The disadvantage is the cost and time spent analyzing such a comprehensive sample of data.

According to [69], there are two types of questionnaires. The first is a self-administered (i.e. the respondent can conduct the questionnaire without the researcher being present). The second is a researcher-administered (i.e. the researcher is present and asks each question in turn). Researcher-administered can be done face-to-face or by telephone.

The questions in the questionnaires should be brief, which means that they should ideally be 20 words or less. They should be relevant to the purpose of the questionnaire. Also, they should be unambiguous, which means no use of words with multiple meanings. In addition, the questions should be precise and objective.

The question and response design can be in many formats. It can be yes or no questions. Another alternative question formulation is agree or disagree. Also, they could be formulated as the degree of agreement or disagreement [69].

7.5 Interviews

[69] defines an interview as a particular kind of conversation between people. It has a set of assumptions that do not apply to regular conversations. The purpose is for the interviewer to gain information from the interviewees. That means the agenda and the discussion have been planned to steer the conversation to the topic of interest. It is also understood that the interviewees words are "on the record" and can be used later by the researcher [69].

Interviews are suitable data generation methods when a researcher needs to obtain detailed information. Some questions are very complex, and for such questions questionnaires are not appropriate. Interviews, on the other hand, allows for further explanations regarding the question. Interviews also give the researcher an opportunity to explore emotions, experiences or feelings that could be difficult to obtain through questionnaire responses. Furthermore, interviews can investigate sensitive issues or privileged information that the respondent probably is not willing to share on a questionnaire.

- **A structured interview** uses pre-determined questions. The questions are identical for every interviewee. The interviewer reads each question and takes notes on the responses. In a structured interview, it is important to read the questions in the same way. Also, it is

important to note the answer without commenting on it. That is because the interviewer is not supposed to reveal their views on the topic [69].

- **A semi-structured interview** consist of a list of themes to be covered. Some questions are prepared. However, it is possible to change these questions during the interview. It all depends on the flow of the interview. Furthermore, it is possible to add follow-up questions that arise. In semi-structured interviews, the interviewees can speak more in detail on the different themes, and they can also introduce their issues [69].
- **An unstructured interview** is more about introducing a topic, and let the interviewee develop their individual ideas. The interviewer has less control over the conversation because it flows more freely. The interviewer shall try to interrupt the interviewee as little as possible [69].

7.6 Card Ranking

Card ranking, card sorting and also called the Q-method is a qualitative research method, and it was first introduced by the psychiatrist William Stephenson (1935). It is a method used for ranking different concepts against each other. This method gives cards with either statements, words, pictures, instructions tasks to the test participants. Then the they are asked to sort the cards according to the researched instructions. It can be approval versus disapproval, like versus dislike, lowest versus highest [79]. The instructions are dependent on the goal, and after sorting the cards the participants explain why they sorted the cards as they did. The method is used to understand the relation between items, and the participants' perception of organizing them. The advantage is that it gives a comprehensive view of the individual opinions.

7.7 Data Analysis

This section describes different ways of how qualitative and quantitative data can be analyzed.

7.7.1 Analysis of Qualitative Data

Qualitative data includes nun-numeric data (e.g. words, images, sound) gathered from interviews, diaries, recordings, and documents. According to [80] there is no right way to analyze qualitative data. However, most qualitative data analysis tries to identify the most important verbal, visual, aural themes and patterns [69]. When analyzing data [69] suggests preparing the data before going through it. That gives a general impression about the data. Later, the goal to categorize the data into three categories. The first category is data that has no relation to the research project and is not needed. The second category is data that gives descriptive information. The last category is information that is relevant to the purpose of the research project.

The information in the last category needs to be placed under various themes depending on the content. [69] suggests that this can either be done deductive or inductive. Deductive means that the categories are from theories found in the literature beforehand. Inductive means that the

categories are observed in the data. The last step is to refine the categories and look for patterns and connections. Sometimes it is also helpful to use tables and charts to analyze the data. Also, it is possible to do other quantitative analysis on the data.

Grounded theory is a particular inductive approach to analyzing qualitative data where the intention is to see what theory emerges [69]. If theory emerges from an analysis of field data, that means the theory is grounded in the field data. However, only a "light version" is used in this research, because grounded theory has many particular practices. However, all of them are not applied in this research.

7.7.2 Analysis of Quantitative Data

There are several ways to analyze quantitative data. Tables, charts or graphs can be used to help the researcher see patterns. Also, simple descriptive statistical techniques (e.g. mean, median, mode), can be used. There are also more complex statistical methods that can be applied.

The best-suited analysis depends on the data, and there are four kinds. The first is nominal, which describes categories and does not have a numeric value. The second is ordinal data, which are numbers allocated to a quantitative scale. That can, for instance, be ranking of students. The Likert scale is typically ranked data. The third is interval data, which is like ordinal data, but this also shows the measurements between each student in the ranking. The last is ratio data, and that is typically people's age, weight or height [69].

Interpreting this data means putting meaning into it. That means understanding what the results show, what it implies, what is important, what is of relevance for the projects and how do they relate to the literature about this topic [69].

8 | Validity

It is necessary to discuss the validity of the research project. Furthermore, to discuss the methodologies of how the qualitative and quantitative data was collected. This chapter gives an explanation of objectivity, internal validity, external validity, and ecological validity. However, the validity of the research project will be discussed in Chapter 18.

8.1 Objectivity

According to [69], objectivity is the degree to which the research is free of researcher bias and distortions. Therefore, it is important to discuss the objectivity of a research project when using qualitative methods. Similarly, reliability focuses on repeatability, which means whether a study can be can be replicated later with similar results. To increase objectivity, the goal is to minimize the facilitators unintended influence on the participants. One way to reduce such influence is for the researchers to analyze the data by watching a video recording of the session, and evaluate their impact afterward [81].

8.2 Internal Validity

According to [69], internal validity is to which extent the results are accurate, match reality and are measured correct. Furthermore, that there is no ultimate benchmark against any of the findings. Similarly, according to [82], internal validity is defined as the degree to which the research methods accomplish the purpose for which they are being used.

[69] also argues that an experiment has good internal validity if the measurements obtained, are caused by the manipulations provided by the known dependent variable, not by any other factor. Threats to internal validity include faulty instruments used for measurements, maturation, and history.

During a usability test, to ensure internal validity, the facilitators needs to make sure that there is no ambiguity in the information and questions. Also, it is crucial to state the purpose of the tests and to ensure that all participants understand it.

8.3 External Validity

According to [69], external validity is the degree to which findings are generalizable to different people, settings, and times and depends on how representative the research samples are. The concept concerns whether the results can be generalized to the intended population that is being studied. [69] argues that the common threats to external validity are typically too few participants or non-representative participants.

8.4 Ecological Validity

According to [83] the ecological validity of a study means that the methods, materials and setting of the study must approximate the real-world that is being examined. It is concerned with the world around the research. Consequently, this is related to how the equipment, methods, and settings are done, in comparison to the real-world.

9 | Research Design

This chapter describes the research methods used in this study in detail. It includes both qualitative and quantitative methods, and the combination of these methods aims to get a deep understanding of the suitability of using an OR simulation of a traffic accident for persuasive purposes. The methods also intend to measure attitude and behavior change regarding each of the three medias. Additionally, the goal is to compare the persuasiveness and to reveal which is considered the most persuasive. Lastly, to discover possible positive or negative factors that influence behavior change. All of the methods used will be elaborated further in the following sections.

Qualitative Methods	**Quantitative Methods**
Semi-structured Interviews	Presence Questionnaire
Card Ranking	Simulation Sickness Questionnaire
	Questionnaire Persuasiveness
	Card Ranking

Table 9.1: Research Methods

9.1 Presence Test

Relatively often when a system is being developed, it is necessary to measure its usability. Usability is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in specified contexts of use [70]. Usability is usually measured with a usability test. It is possible to read more about usability in Section 7.2.

Since the system developed in this research project is a virtual reality simulation, there are no specific tasks that the user has to conduct. Therefore, it would not make sense to measure the usability. As mentioned previously in Chapter 4, virtual reality has several other factors that determine the quality of it. These are factors like presence, immersion, realism, distractions, engagement and involvement. Therefore, instead of a usability test, these factors were measured to clarify the quality and to be able to make indications about the users' experience of presence. The name given to this test was: a presence test. Below, all the different methods used are described in detail.

9.1.1 Questionnaire - Background Information Form

To gather information about the participants' background, they were asked to fill out a background form regarding their age and sex. Additionally, they filled out information regarding motion sickness, due to the close relation to simulation sickness. A participant that quickly gets motion sick might have an increased chance of getting simulation sickness (see Section 3.7). Furthermore, severe cases of simulation sickness might lower the experience of presence [6]. Lastly, they filled out information about their previous experience with Oculus Rift. The complete background form can be seen in Appendix C.

9.1.2 Questionnaire - Presence

After the participants had tested the simulation, they were asked to fill out a presence questionnaire. It was done to collect quantitative data regarding the OR simulation. The questionnaire was made based on the literature regarding measuring presence (see Section 3.6). Also, it contained several statements where the participant had to choose to which extent they agreed or disagreed. The scale was a 5 point Likert scale, where the range went from strongly disagree - strongly agree.

In total, the questionnaire had seven topics. The first two topics aimed to get data about the participants experience of presence and immersion during the simulation. The next topic intended to find out how realistic they felt the simulation was. The fourth topic, distractions, aimed to discover the quality of the visual. Furthermore, to determine if lags and delays were distracting. The fifth topic regarded the participants' engagement and involvement. The sixth topic was specified towards the sounds in the simulation. The goal of the last topic was to get information about the participants feelings and reactions towards the simulation, more specifically to find out if the simulation gave an uncomfortable feeling connected to traffic accidents. It is possible to see the questionnaire in Appendix D.

9.1.3 Questionnaire - Simulation Sickness

The participants were sitting still during the simulation. However, visually they were moving forward. That situation could be confusing for a human brain and cause simulation sickness. Since simulation sickness symptoms could reduce the experience of presence, a simulation sickness questionnaire (see Section 3.7) was given to see if the participants felt any discomfort.

There are several symptoms connected with simulation sickness (e.g. nausea, difficulty focusing, dizziness, vertigo, headache). The simulation sickness questionnaire addressed all of them, and the participants answered to which extent they experienced these symptoms. The scale went from none to severe.

The questionnaire was created based on an existing simulation sickness questionnaire by [84]. However, it was modified and translated to Norwegian, to make it easier to understand for the participants. It is possible to see this version of the questionnaire in Appendix E.

9.1.4 Semi-structured Interview

Semi-structured interviews were also conducted. The goal was to get qualitative information regarding the simulation. Moreover, since there were developed two similar versions of the simulation (i.e. driver seat and backseat, see Section 10.2), the goal was to discover which version was preferred for persuasive purposes. Furthermore, the semi-structured interview asked about suggestions for improvements in order to get a more powerful experience. It is possible to see the complete interview guide in Appendix F.

9.2 Persuasive Test

After analyzing the results of the presence test, changes were made in the simulation. It is possible to read more about these changes in Section 10.8. Next, another experiment was conducted: a persuasive test. The goal was to discover the persuasive impact each of the three medias (i.e. the OR simulation, the campaign video and RLA) had on the target users. Additionally, to reveal which of the media the users considered the most persuasive (i.e. persuade the target users to avoid risky behavior in traffic). Lastly, to discover possible factors having a positive or negative impact on persuasion. Therefore, this test was named a persuasive test. The sections below describes all the different methods used to conduct this test.

9.2.1 Questionnaire - Background Information Form

During the persuasive test, it was important to gather the participants' background information. Therefore, all the participants filled out a background form. They filled out information about their age and sex. In addition, they filled out information regarding their previous use of Oculus Rift. Unfortunately, one important question was forgotten and not added to the form: if they usually spent much time playing computer games. However, it was asked orally to all participants, and the answers were noted on the background forms. The next question asked regarding their drivers license, and the last question asked if they had been in a traffic accident before. It is possible to see the background form for the persuasive test in Appendix I.

9.2.2 Questionnaire - Attitude, Behavior, and Perception

Three questionnaires were given to the participants during the experiment. However, they had the same questions but were directed towards each media tested: the simulation, the campaign video, and lastly Real Life Auto. Moreover, this questionnaire was also used in the pre-project, which means it is the second time the participant answered the questionnaire. However, only Real Life Auto was being tested in the pre-project.

The participants were asked to fill out the questionnaire immediately after testing each media. It contained six different statements about attitude, behavior and perception, due to these factors relevance to persuasion (see Section 2.1). The participants had to decide to which extent they agreed or disagreed with the statements, and the response formulation was based on a 5-point

Likert scale (i.e. strongly disagree to strongly agree). The statements can be seen below, and the complete questionnaires can be seen in Appendix J.

- **Attitude:**
    1. I think my own attitude regarding risks in traffic is changed after finished testing the medias.
    2. I think other teen's attitudes regarding risks in traffic will change after finished testing the medias.
- **Behavior:**
    3. I think my own behavior regarding risks in traffic is changed after finished testing the medias.
    4. I think teen's behavior regarding risks in traffic will change after finished testing the medias.
- **Perception:**
    5. I think my own perception regarding risks in traffic is changed after finished testing the medias.
    6. I think teen's perception regarding risks in traffic will change after finished testing the medias.

9.2.3 Card Ranking

To get a clear understanding of the individual preferences of which media considered most persuasive; the card ranking methodology was conducted. It is possible to read more details about this method in Section 7.6.

The participants got three cards, each representing a media (see Figure 9.1). The participant had to rank them according to which media they thought had the most persuasive effect on the target users. More specifically, the task was to order the cards based on each media's ability to change teenagers risky behavior in traffic. In addition, the participants had to explain their rankings.

This methodology provided both qualitative and quantitative data. The ranking score gave quantitative data that can be analyzed statistically. Furthermore, the explanations gave qualitative data which provides a broader understanding of the participants' thoughts. It is possible to see the card ranking template used by the facilitator during the test in Appendix K.

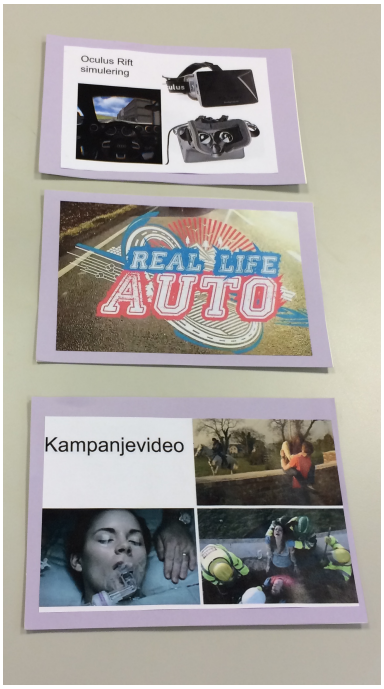


Figure 9.1: Card Ranking

9.2.4 Semi-structured Interview

Semi-structured interviews were also conducted. The goal was to obtain qualitative data about the participants' subjective evaluations of medias. More specifically, the goal was to discover if they thought they had a persuasive effect on the target users. Furthermore, to identify possible factors having a positive or negative influence on behavior change.

There was one interview guide for each media: one for the Oculus Rift simulation, another for the campaign video, and lastly, one for Real Life Auto. Each interview guide had some similar topics. All the interview guides included a topic regarding feelings and reactions towards the particular media. This topic included questions like: what they thought of the video, how they felt, and if they though the media gave an uncomfortable feeling connected to traffic accidents. All of the medias also included questions regarding attitude, behavior, and perception. Within this topic, there were questions about if they thought the particular media could change attitude and behavior. Moreover, they had to explain why they answered as they did. Another topic all of the medias had were immersion and presence. The questions within this category were about if they felt involved, immersed or engaged by the media.

The simulation had two additional topics the other medias did not contain. The first was questions directly connected to the simulation and their thought on it. The last topic asked about suggestions for future use of the Oculus Rift in traffic safety settings.

In addition to these three interview guides, there was one last interview guide. This guide included

some last discussion questions for the end of the session. The goal was to find out what the participant would have done if they had this tasks, what works when it comes to changing their attitudes regarding risky behavior in traffic? Would they continue with any of these medias, or try something completely different?

The original interview guides can be seen in Appendix L.

9.3 Experiment Design

During the persuasive tests, all participants had to test the same three medias. However, according to [85], the order in which each product is tested can influence the participant opinion of it. An example could be that someone prefers the last media best because it the more memorable. To reduce the effect the order biasing the result; the order the participant tested each media was balanced. This order can be seen in Table 9.2.

Participant ID	**Media 1**	**Media 2**	**Media 3**
P01	R	C	O
P02	O	R	C
P03	C	R	O
P04	R	O	C
P05	O	C	R
P06	C	O	R
P07	C	R	O
P08	R	C	O

Table 9.2: Experiment Design - Persuasive Test

The letters C, O, and R, each represent one of the medias as follows:

- **C** - The campaign video. The campaign video is described in detail in Section 5.2.
- **O** - The Oculus Rift simulation. It is possible to read more about the simulation in Chapter 10.
- **R** - Real Life Auto computer game. More details about Real Life Auto can be seen in Section 5.1.

Furthermore, during the presence test, two versions of the simulation were tested. Also, to reduce order bias, the first half of the participant tested the driver seat version first. The second half tested the backseat version first. The order can be seen in Table 9.3.

Participant ID	Version Tested First	Version Tested Second
ID01	Driver seat	Backseat
ID02	Driver seat	Backseat
ID03	Driver seat	Backseat
ID04	Driver seat	Backseat
ID05	Driver seat	Backseat
ID06	Backseat	Driver seat
ID07	Backseat	Driver seat
ID08	Backseat	Driver seat
ID09	Backseat	Driver seat
ID10	Backseat	Driver seat
ID11	Backseat	Driver seat

Table 9.3: Experiment Design - Presence Test

9.4 Data Analysis Methodology

In this research project, an inductive approach was used for all the qualitative data. First, a review of all the data was done to get a general impression. Then, the content was put into three different main categories: data having no relation, descriptive data, and finally, the relevant data. Next, the relevant data was analyzed, and then systematic placed into different categories based on patterns found during the analysis [86].

Part IV

Implementation of the OR Simulation

10 | Design and Implementation

This chapter describes the design and the implementation of the prototype of the traffic accident simulation for Oculus Rift. The first section describes the design and the reasoning behind the design decisions. The next sections describe the integration with Oculus Rift, and the section after that elaborates how the scenery and the animations were created. The next sections describe the driving route and how it was implemented. Furthermore, there is a section regarding the sounds and the sound effects in the simulation. Lastly, there is a section regarding the final version of the simulation, which describes all the changes done after the presence test.

10.1 Designing for Behavior Change

The design process was based on the eight-step model described in Section 2.8. However, the process was modified to fit for designing a virtual reality simulation.

The first two steps were to choose a behavior to target and then to determine the users. These steps were already decided: This research project aims to persuade adolescents (read about target users in Section 1.3) to avoid risky behavior in traffic.

The next step was to find out what prevents the desired behavior. According to Fogg's Behavior Model (see Section 2.4) there are three possible reasons. The first possible prevention is the lack of ability. Suitably, young drivers often have less driving experience compared to elders. However, many adolescents are competent but still choose to take risks. These adolescents are the target users in this project. Consequently, the lack of ability influences the prevention of the target behavior. However, it is not considered the primary cause. The second reason is the lack of motivation. Some adolescents conducts such behavior to achieve an adrenaline rush. On the other hand, people do not wish to be injured or worse in traffic accidents. Unfortunately, many adolescents forget that accidents could happen to everyone. Moreover, many are also impulsive. However, when reminded of the severe consequences, there should be motivation enough to avoid such behavior. Also, people acting on impulse are easily persuaded [29]. Therefore, the lack of a proper trigger is considered to be the primary cause for why the desired behavior is prevented.

The next step in the design process was to discover relevant examples of working persuasive technologies, and then to imitate them. Unfortunately, there has not been found a concrete example that fits this research project. However, virtual reality has previously been used to change behavior related to personal fire safety by giving the users negative feedback when walking into smoke (see

Section 4.1). Furthermore, a report from Sintef indicated that experiencing a traffic accident has a persuasive impact. Therefore, the combination of the fire safety experiment and the report from Sintef is used as a basis for what is being imitated in this research project.

As mentioned, the lack of a proper trigger is considered to be the primary reason the desired behavior is prevented. Furthermore, the fire safety experiment and the Sintef report is being imitated. Therefore, it was decided to create a first-person simulation of a traffic accident for Oculus Rift with an intention of using it as a trigger. Hence, having the simulation generate a negative memorable experience related to traffic accidents. Additionally, to show the users the link between cause and effect, and produce the underlying message of not taking risks in traffic. The primary argument for using Oculus Rift was its ability to increase the sense of presence, and consequently making the experience memorable. Memorability is essential for making the simulation relate to the core motivators: sensation (i.e. avoid pain) and anticipation (i.e. the fear of something bad happening). It is possible to read more about the core motivators in Section 2.4.

The next steps were to create the simulation, test it and iterate quickly. While designing the traffic accident, time was a limitation. Therefore, the scenery was create based on existing 3D models (see Section 10.3). Consequently, several design decisions were already made. It is possible to read more about the development of the scenery in Section 10.3. Lastly, since the simulation was considered to be a prototype (see Section 7.3), the last step: "expand on success" was not applicable.

Another design decision was to have the participant sit inside one of the accident vehicles (henceforth referred to as the main car) to increase the sense of presence and immersion. Also, to create the link between cause and effect, it was decided that the main car would drive slow and controlled at the beginning of the simulation. However, towards the end it would speed up and cause the accident. It is possible to read more details about the decided driving route in Section 10.5.

Furthermore, the simulation was supposed to give negative emotional feedback invoking mild fear. Mild fear is an effective when it comes to persuasion because it forms attitudes based on people's instinct [58]. Therefore, a decision was made to have the main car collide with a bus because it is a heavyweight vehicle. It was also decided to add a scream right before the collision. Additionally, an intense crash sound was added at the moment of impact. Lastly, a heart beat sound was added as a representation of a negative consequence to the participants body.

Initially, the goal was to add more negative feedback (e.g. broken glass, blood, injuries) after the impact. However, creating such animation is time-consuming, and, unfortunately, there was no time to produce it. It is possible to read the details of the creation of the simulation in the sections below.

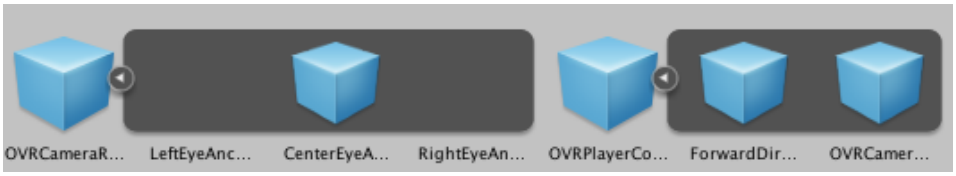
10.2 The Unity OR Integration

As mentioned in Section 6.2 Unity3D is an integrated development engine for developing 3D multi-platform games and other interactive content. It was used as a development engine in this research project to create a prototype of an Oculus Rift traffic accident simulation. Oculus Rift is a head-mounted display produced by Oculus (see Section 6.1), which brings an incredible virtual experience. Such technology could make the simulation more impactful and memorable.

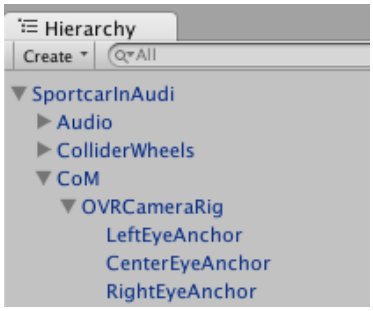
While developing the simulation, the Oculus Rift SDK integration for Unity 3D (Unity Integration

Package) was used. The Oculus Rift Unity Integration gives the opportunity to add an "OVRCameraRig" or an "OVRPlayerController" to a unity scene. A unity scene is the environment where a game is happening, and it contains the game objects. Furthermore, a game can have several scenes, but there were only one in this simulation. The camera rig and the player controller are game objects that can be placed in a unity scene. Such objects put the user in the scene when the game starts (i.e. when they put on the OR). However, these two game objects are slightly different. The camera rig has a left, right and center eye anchor. The eye anchor makes sure that wherever the camera rig is placed in a scene, this is the place that a user will be set when using on the OR. In addition to the eye anchors, the player controller also has a "ForwardDirection" package. This package allows the users to move forward as well. It is possible to see this in Figure 10.1(a).

In this simulation, the camera rig was used because the users point of view where supposed to be from inside a car. Furthermore, to have the same position at all times and to make sure the camera rig followed the car; the camera rig was set to be a child object of the car. In this way, the camera where attached to the cars coordinates. It is possible to see this in Figure 10.1(b).



(a) Camera Rig versus Player Controller



(b) Camera Rig as Child Of Car Model

Figure 10.1: Oculus Rift Unity Integration

Two different versions of the simulation were created. In the first version, the camera rig was placed in the driver seat (i.e. as if the user were driving). In the second version, the camera rig was put in the backseat of the car as if the user were a passenger. These two versions were tested against each other to find out which one was the most impactful, and the results of this test can be found in Chapter 12.

(a) Version 1 - Driver Seat

(b) Version 2 - Backseat

Figure 10.2: Two Versions of the Simulation

Lastly, to be able to run the Oculus Rift, the Oculus SDK runtime was downloaded and installed [1].

10.3 The Scenery

First, a unity scene was created. However, 3D modeling an entire environment from scratch would have been extremely time-consuming. Since this research project had a time limitation, the scene was based on existing 3D models. These models were gotten from the asset store (see Section 6.2), and from the car a physics package (see Section 6.3). The latter package contained several existing 3D models (e.g. cars, roads, crossings, streetlights, trees, grass, sand and a variety of buildings). Additionally, this package also included an existing base for a city, which was built upon and modified.

[1] https://developer.oculus.com/downloads/

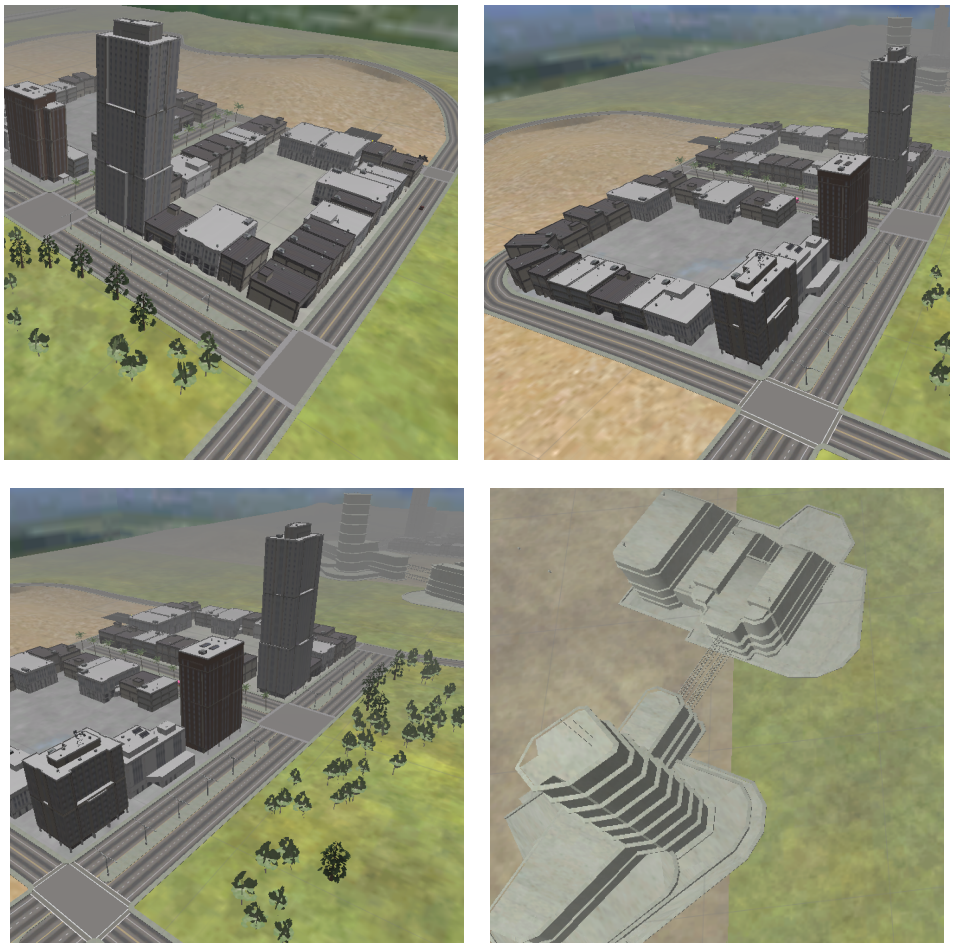


Figure 10.3: The Scenery 1

Adding 3D models (i.e. prefabs) into the scene, was mainly done by dragging and dropping; dragging the 3D model from the prefabs folder and into the Unity scene. Once a prefab was added to the scene, it was possible to inspect and modify its components in the inspector panel (see Section 6.2). This panel gave the opportunity to add transforms (i.e. position, rotation, and scale). It was also possible to add additional components. As an example, the buildings in the scene had "mesh renderers" and "mesh colliders" added, which added materials and texture to the buildings in the scene. Similarly, sand and grass material were added to the ground, and asphalt material to the roads. Lastly, some of the components were added by using scripts. However, the drag and drop method were mostly used. It is possible to see the final scene in Figure 10.3 and Figure 10.4.

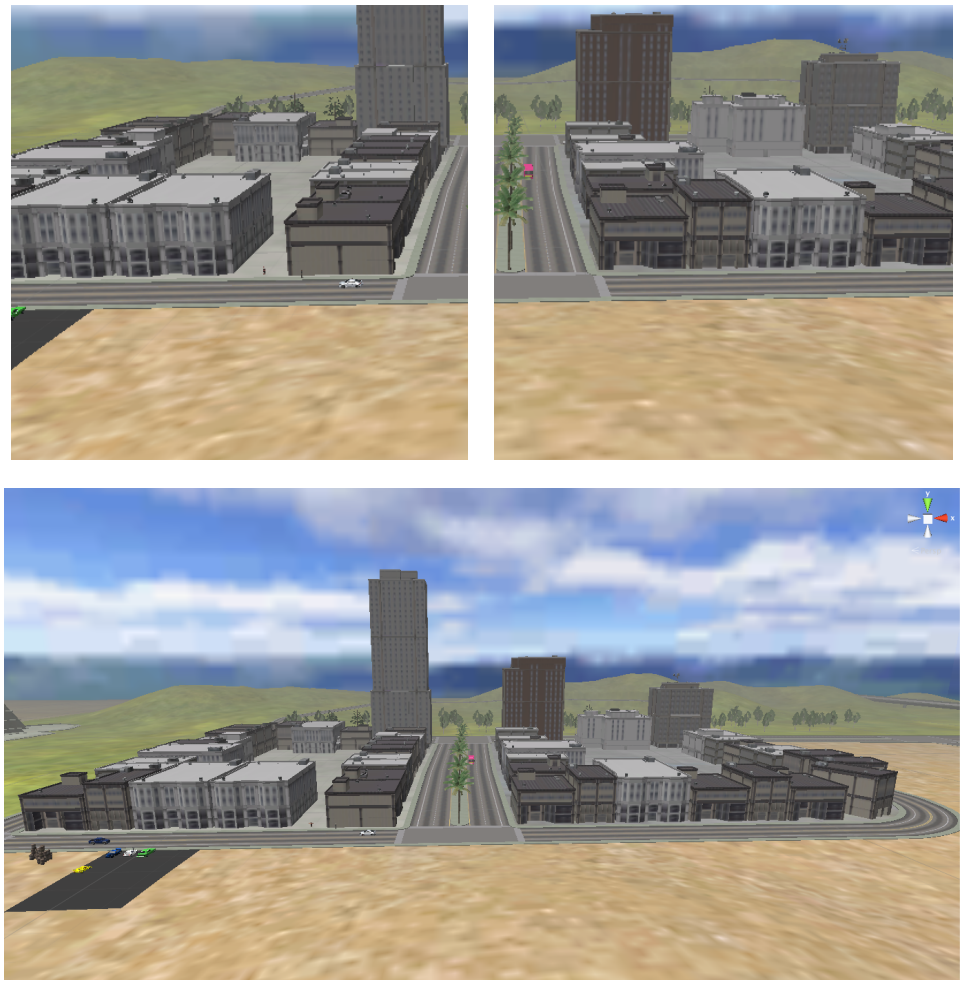
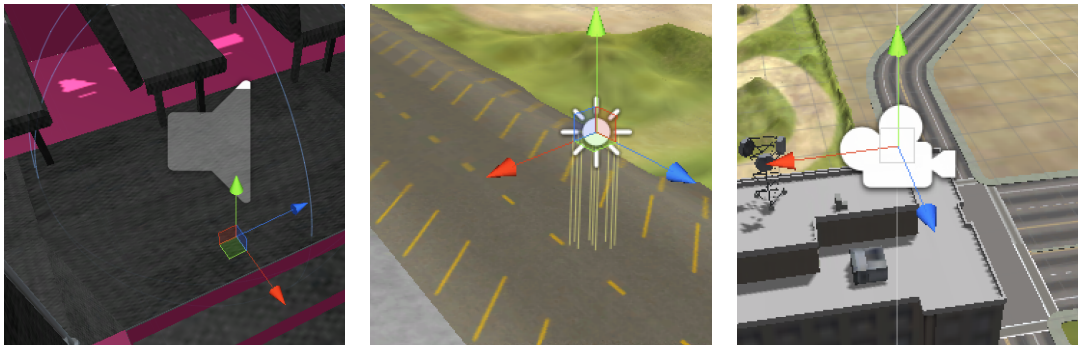


Figure 10.4: The Scenery 2

While adding the components to the scene, measures were made to ensure order and stability regarding the transforms: the game objects were assigned children of the related objects in the hierarchy panel. It is possible to see from Figure 10.5 that all the prefabs (e.g. buildings, ground, road, trees, avatars) were made children of the city. Consequently, all these objects were moved with the city's coordinate system as a reference.

Figure 10.5: The Scenery Hierarchy

Sounds, light and cameras were also added to the scene. The sound was added to get the sound effects from the cars and other game objects (see Figure 10.6(a)). It is possible to read more about the sound effects in Section 10.7. Also added to the scene was a light component, which consequently generated light in the scene (see Figure 10.6(b)). Lastly, a camera component was added to the scene, which gives an overview of the scene. The camera can be viewed in Figure 10.6(c).



(a) Sound in Scene (b) Light in Scene (c) Cameras in Scene

Figure 10.6: Sounds, Light, and Cameras

10.4 Animations

Animations were added to the simulation to make it as realistic as possible. The animations were passengers and pedestrians. The purpose was to produce "life" and action in the city. The passengers and pedestrians where avatars, or 3D models of humans, and they were gotten from Mixamo [2]. Mixamo is a website where it is possible to create and animate 3D characters. Unfortunately, most of the 3D model and the animations costs money. However, a few characters were free for download, but the had no animations attached. The characters used can be seen in Section 10.4.1.

Figure 10.7: The T-Pose

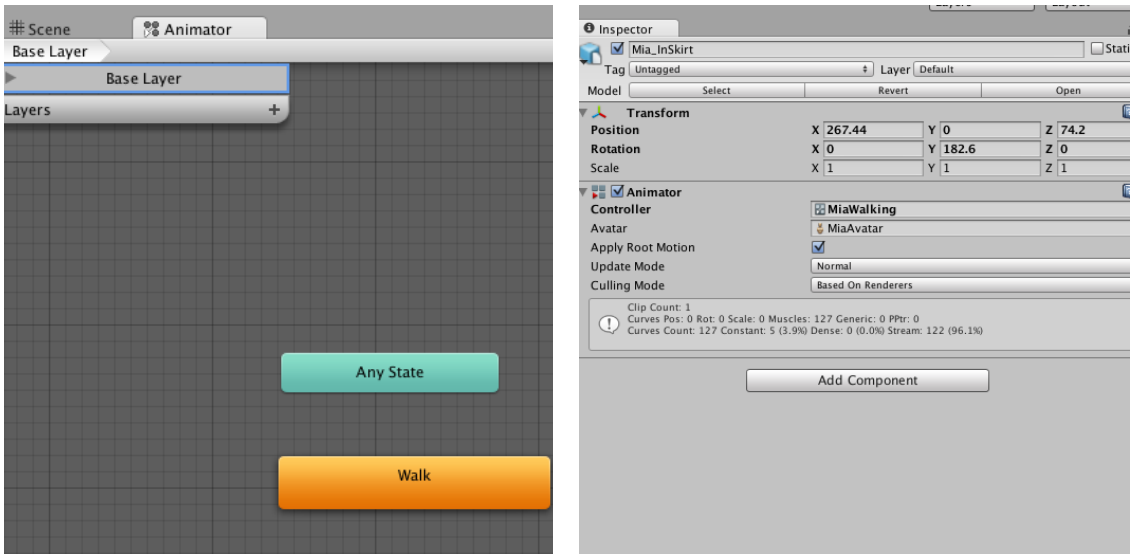
As mentioned, these characters did not have an animation attached. As default, they were set in a T-pose (see Figure 10.7). Therefore, animations were downloaded from the asset store, and they were modified with Unity's animation view to fit the avatars. The animations used in the final product where: walking forward, idle waiting poses and sitting poses. They can be seen in Figure 10.10.

In order to get the Mixamo's characters to play the different animations, different animator controllers were created using Unity's animator view (see Figure 10.8(a)). An animator controller is a state machine that determines which animation is currently being played on an avatar. Fortunately, only one state was needed for each avatar in this research project. The animator controllers created for this project was: walking, sitting, and idle waiting poses. Each had their default state. As an example, it is possible to see the default waking state (orange) in Figure 10.8(a). That means the avatars that had this controller attached played the walking animation throughout the whole simulation.

After positioning the avatars to the scene and creating all the animator controllers, the avatars and the animations were linked. It was done by adding an animator controller component in the Inspector panel, and then choosing the particular animator controller. This can be seen in

[2] https://www.mixamo.com/

Figure 10.8(b). In this Figure, it is possible to see that an animator controller is attached to the "Mia avatar". This operation was done for all the avatars in the scene.



(a) The Animator View

Figure 10.8: Animation Controllers

However, before attaching an animator controller to an avatar, the model had to be configured to make sure they were appropriately linked. Otherwise, the animation would not fit the avatar. The configuration process is presented in Figure 10.9. It was essential to choose the avatar to be a humanoid 3D model in the "Rig tab". Next, all the body parts of the avatar had to be placed accurately (see Figure 10.9). After finishing the configuration process, the avatars were ready to be rendered with their attached animations. When starting the simulation, the animations were rendered immediately, and they were rendered until the simulation was stopped.

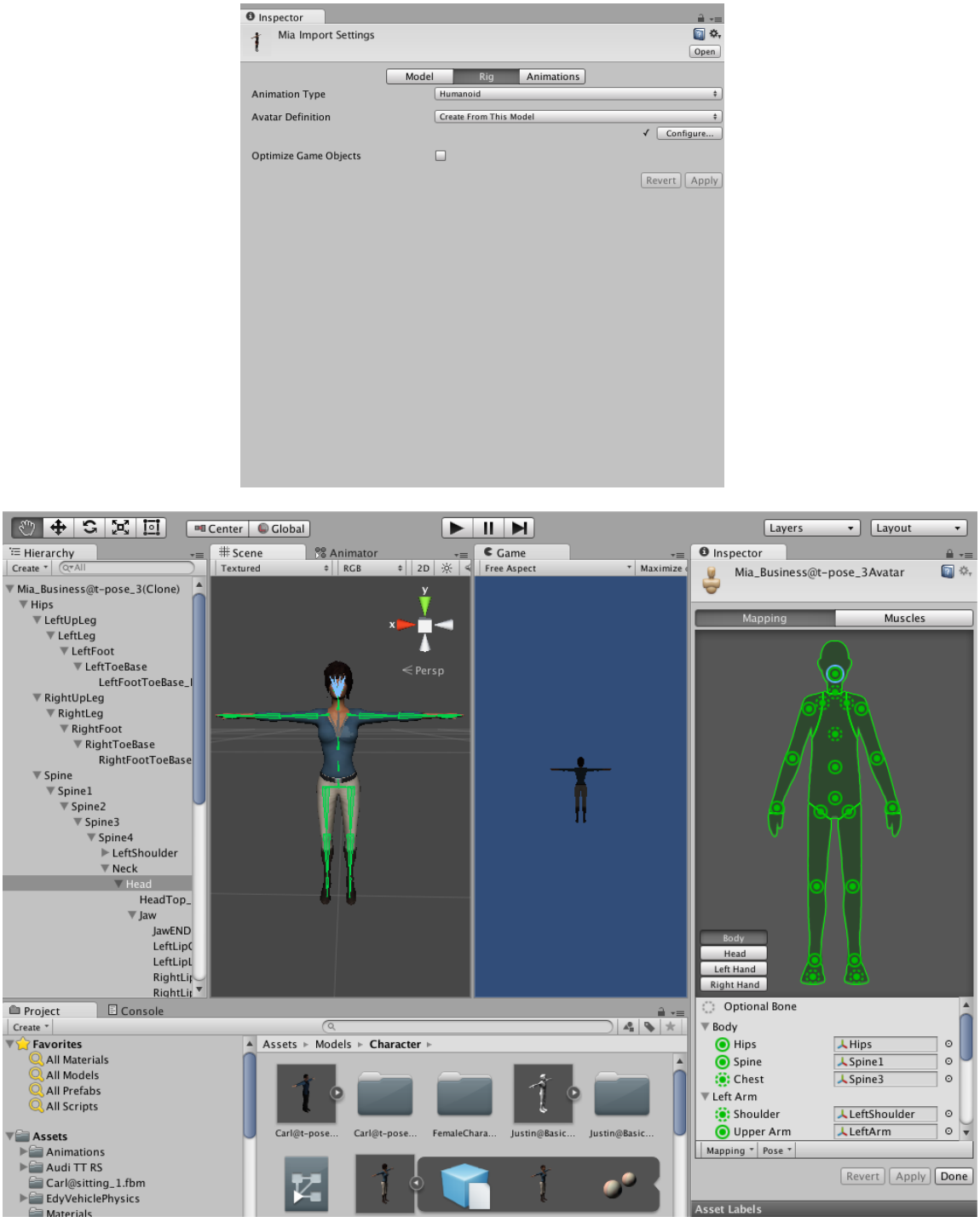


Figure 10.9: Configuration of Avatars

10.4.1 Avatars

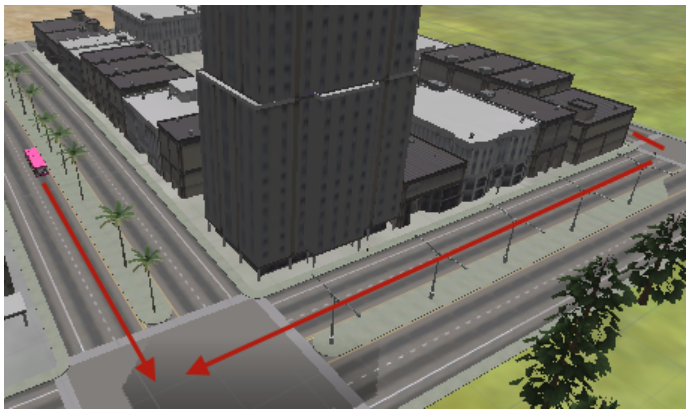
These are the avatars or 3D models downloaded from Mixamo and used in this simulation. They were placed around as passengers and pedestrians to create more life and action during the simulation. All of them were placed somewhere along the driving route, so they would be visible during the simulation.

Figure 10.10: Avatars in Scenery

10.5 The Driving Route

The main car in the simulation is a white Audi, and the users are placed inside this car during the simulation. The driving route starts where the main car can be seen in Figure 10.11(a). The main car then follows the red arrow around the city. In the beginning and almost until the end of the route, the Audi has a controlled velocity. During this time, the main car passes several pedestrians and to two pickups (see Section10.6.1).

(a) Beginning



(b) End

Figure 10.11: The Driving Route

However, after the last turn, the car suddenly speeds up. When the car is nearly at the intersection, a bus suddenly appears. Unfortunately, at that time it is too late to avoid a collision with the bus. It is possible to see from Figure 10.11(b) that the accident happens about where the two red arrows meet. It is possible to see the collision in Figure 10.12.

(a) Outside View

(b) Inside View

Figure 10.12: The Collision

10.6 Car Models and Car Physics

Spending time developing car physics is out of the scope of this project due to the time limitation. Therefore, a car physics package (see Section 6.3) was used.

The car physics package was originally made to take input from the users through the keyboard. However, this had to be changed since the goal was to develop a simulation with no user input. It was done by adjusting the UpdateCar function in the CarControl script to take in variables for acceleration, steering, and handbrake, instead of reading keyboard input for these values.

A new script, SceneMaster, was created to control all the actions in the scene, from which the simulation was coordinated. The script controls the cars by calling the UpdateCar function in the CarControl script with appropriate arguments (e.g. accelerate, steer, handbrake). The relation between the scripts can be seen in Figure 10.13.

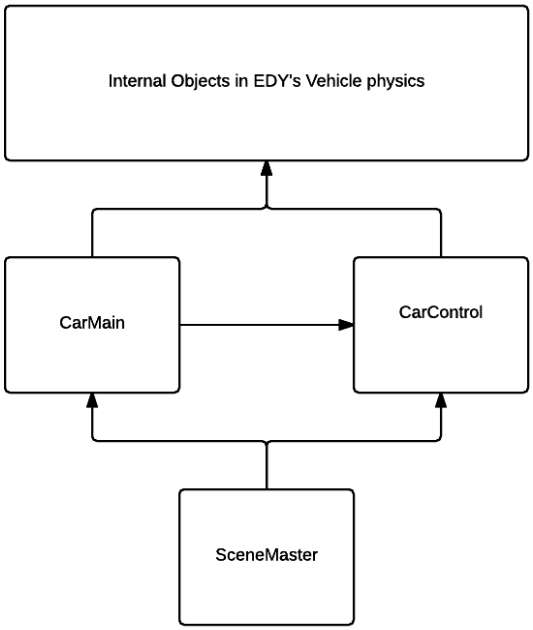


Figure 10.13: The Relation Between Classes

The main car is controlled based on coordinated or checkpoints. It was based on checkpoints due to non-perpendicular roads in the scene. Such points were necessary to keep the car in the middle of the road during the stretches where the car moved straight forward. In addition, they were necessary during turns because the car had to start turning on a given checkpoint, and also to make adjustments before straightening out to end the turn. This method was needed to create an accurate and realistic driving flow.

Another reason for why coordinates were used to steer the main car was because it is always some noise related to car physics. Such noise can create minor differences in the simulation at every execution. The differences happen due to variations in the framerate. The best way to avoid such differences is by using coordinates to steer the main car instead of, as an example, time.

The steering of the other vehicles (i.e. bus and pickups) were based on time instead of coordinates. Also, the controlling of pedestrians were based on time. The reason time was good enough was because their movement was straightforward for a short amount of time. The cars were started by using co-routines in Unity, which is a function that can suspend its execution for a given amount of time. After the time suspension, the updateCar function was called with the particular vehicle and accelerate as arguments.

To be able to synchronize all the moving object, they were relocated to their initial coordinates at the start time. To begin the simulation; the space key had to be pressed. The reason for this was because the Oculus Rift integration had a health and safety warning that could not be removed (see Figure 10.14). However, the warning label disappeared automatically after a given amount of

time. Therefore, the method of pressing space to start the simulation gave a more controlled initial time. Furthermore, it offered the possibility to make final adjustments and position the user before starting the simulation.

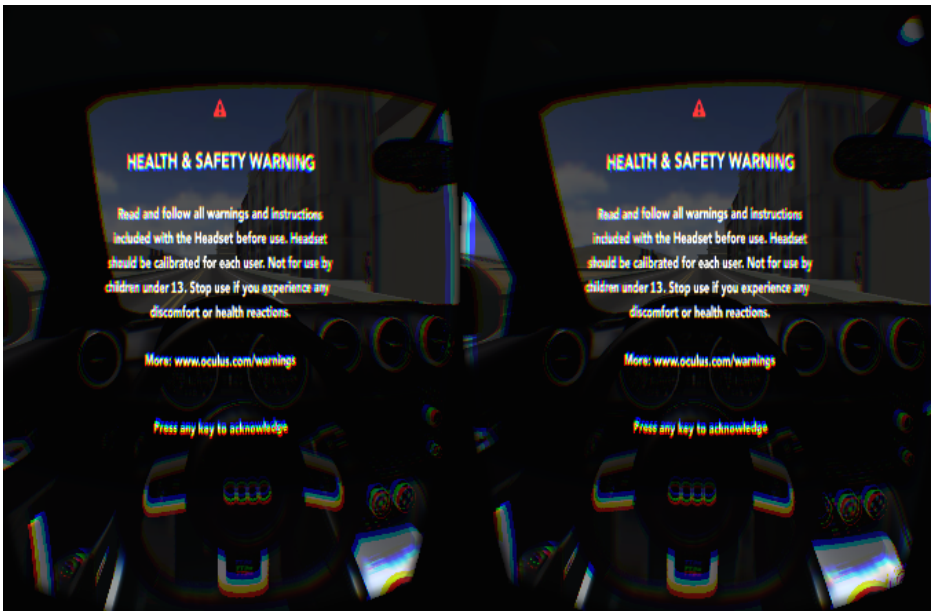


Figure 10.14: Health and Safety Warning

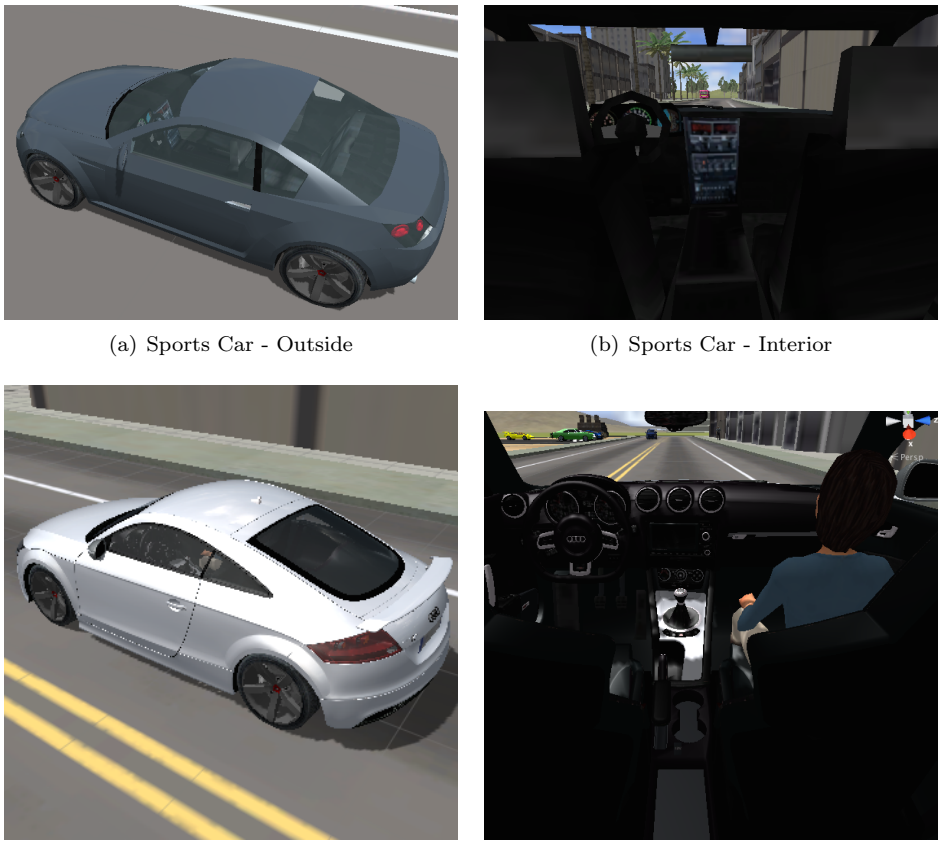
10.6.1 Car Models

Three vehicles from Edy's Vehicle Physics were used, and they can be seen in Figure 10.15. During the simulation, the main car passes a red and a blue pickup. The first passing (red pickup) happens during the first straightforward part. The pickup is started by using a well-timed co-routine. When the main car gets closer, the time suspension is finished, and the updateCar function is called, then it begins to move forward. Right after the main car has passed, the pickup slows down and eventually stops because the updateCar function is not called continuously. However, this is not observable from inside the main car. The same happens with the blue pickup during the second straightforward part, and lastly with the bus at the end of the simulation. Moreover, in the end the main car collides with the bus.

(a) The Red Pickup (b) The Blue Pickup (c) The Bus

Figure 10.15: Vehicles in the Simulation

Lastly, there is a vehicle from Edy's Vehicle Physics package that is not visible in the simulation. This car is the sports car, which can be seen in Figure 10.16(a). Unfortunately, this vehicle had very low quality on the interior of the car (see in Figure 10.16(b)). Since the user is situated inside of the car during the simulation, it is crucial to have excellent 3D model quality. If the quality is low, the simulation gets less realistic. Secondly, it increases the chances of getting symptoms of simulation sickness. For this reason, the Audi 3D model was placed on top of the sports car, and the sports car was made invisible. The interior of the Audi is much more detailed, and the quality it is significantly higher. The comparison of the interiors can be seen in Figure 10.16.



(a) Sports Car - Outside

(b) Sports Car - Interior

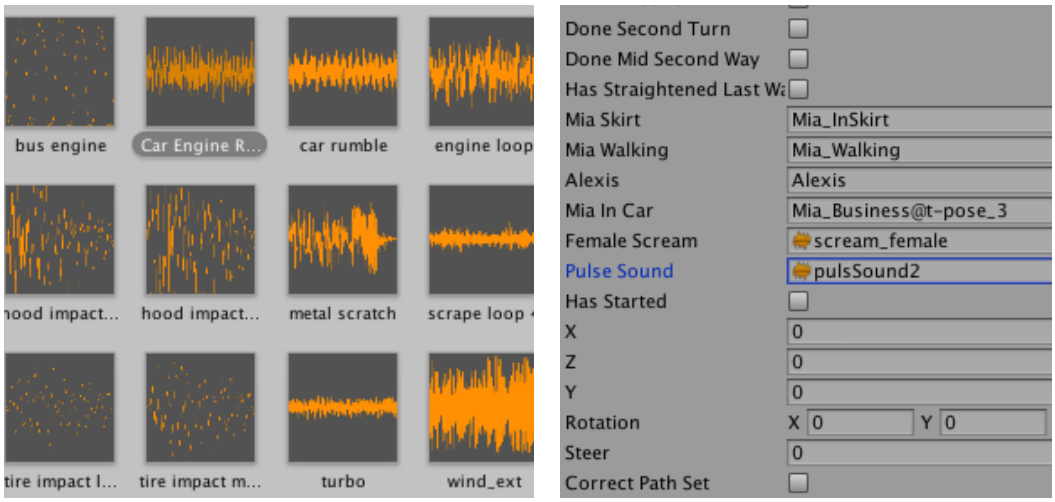
(c) Audi - Outside

(d) Audi - Interior

Figure 10.16: Audi versus Sports Car

10.7 Sounds

Edy's Vehicle Physics already had a script, CarSound, which controlled different sounds related to the car physics. The package included several sound effects: engine sounds, turbo, skid sound, and metal scratch. A list of the various audio files can be seen in Figure 10.17(a). In addition to the existing sounds, a collision sound was added, and the audio clip was connected to the "Body Impact" field in the inspector panel. Since the car physics package already included collision detection, this clip played during an impact with the car's body. The new collision sound was added to create an illusion of a more intense and severe moment of impact.



(a) Sounds From Edy's

(b) Attaching clips in the Inspector Panel

Figure 10.17: The Simulation Sounds

There were also two additional sounds added. The first was a female scream sound, and it played right before the collision with the bus. The second was a heartbeat sound that played immediately after the collision. In order to play these sounds, two AudioClip components were added to the SceneMaster script. In the inspector panel, the respective clips were attached to the AudioClip components (see Figure 10.17(b)). Furthermore, to play the clips a "PlayOneTime" function was created in the SceneMaster script. This function took in the appropriate arguments (i.e. audio clip, transform, volume, and pitch). Additionally, two functions were created to start each clip, and this function called the PlayOneTime function with the respective clips as arguments. Lastly, the start clip functions were called to the update function with a co-routine function.

As mentioned, the PlayOneTime function also took in a transform as an argument. In this case, the transform was the passenger avatar that had an AudioSource attached. In Unity, an AudioSource has to be attached to game objects to play sounds. An example can be seen in Figure10.6(a) where the AudioSource is connected to the car. Also, the heartbeat sound passed the passenger avatar as argument when calling the PlayOneTime function. However, since this sound had the goal of imitating the users own raising heart beat, this sound was made a 2D sound instead of a 3D sound. If it were a 3D sound, then the sound would have come from the passenger instead.

10.8 The Final Version

Several changes were done in the simulation after the presence test, and this section describes them in detail. These changes were based on the feedback from the participants (see Section 12.4). It is possible to see all the results from the presence test in Chapter 12.

First, it was decided to use the driver seat version because most of the participants preferred

it. Secondly, several participants experienced the sound from the car to be high and unnatural. Consequently, the car sound was significantly lowered. Also, the volume of the collision sound was heightened. Several participants also felt that the turns were a bit sharp. Therefore, to get a more natural driving flow; additional checkpoints were added to the turns.

The last issue that the participant commented on was the moment after the collision. They did not believe that it reflected the seriousness of a traffic accident. Unfortunately, creating animations is very time-consuming, and there was no time for it. Hence, it was decided to fade the screen to black after the collision instead. This fading represented that the participant died at the end of the simulation (see Figure 10.18). Except for these changes, everything else in the simulation was the identical as described previously.

Figure 10.18: The Final Version

Part V

Research Procedure and Results: Presence Test

11 | Research Procedure - Presence Test

This chapter describes the research procedure for the presence test. All the qualitative and quantitative methods from Section9.1 were used. The first two sections describes the planning and recruitment phase. The next sections describe the participants, the location and the equipment needed. Lastly, the test procedure will be described, as well as the problems and challenges with the conduction.

11.1 Planning

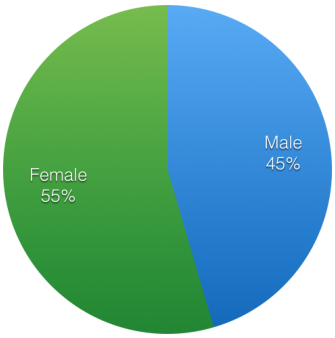
In the planning phase, a test plan was created to be prepared for the test (see Appendix A). It included the goal of the test, which were to measure the participants experience of presence and immersion during the simulation, due to these factors close relation to persuasion. More accurately, it measured presence, realism, distractions, awareness, immersion and feelings towards the simulation. These are the factors that, according to the literature (see Chapter 4), are the key elements in making judgments about presence and immersion. In addition, the test aimed to discover if the simulation gave any symptoms of simulation sickness. Lastly, there were two different versions of the simulation created, and the test also intended to find out which one to use during the persuasive test on the target audience.

Two questionnaires had to be prepared for this test. The first was the presence questionnaire, which can be seen in Appendix D. The second questionnaire was the simulation sickness questionnaire, which can be seen in Appendix E. Additionally, an interview guide (see Appendix F) was created to find out which version of the simulation to use (i.e. the driver seat or the back seat version). Moreover, to get more qualitative data about the simulation.

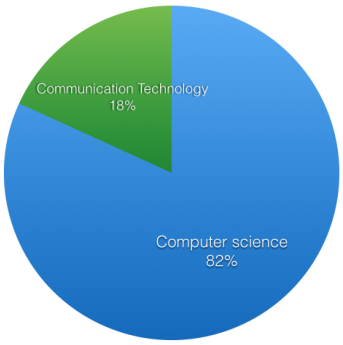
The test plan also included the practical information about the test (i.e. when and where). It also included a list of the equipment needed. For the conduction, it included a step-by-step plan. Additionally, it included definitions for critical errors and non-critical errors specifically for this research project. Furthermore, the test plan included objectives for completion rate (100%) and error-free rate (80%). It also included the goals for the two questionnaires, which is a total score above average.

11.2 Recruitment and Participants

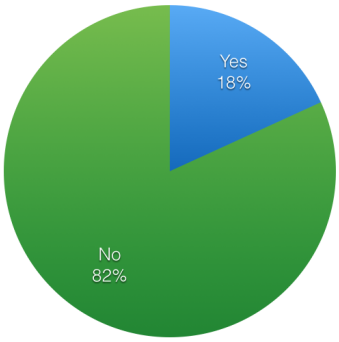
Fellow students were recruited to be participants in the presence test. The students mainly majored in computer science students, but there were also some majoring in communication technology. Since one of the goals was to get constructive feedback on the simulation, computer science students were qualified. Below is an overview of the 11 participants recruited and their background.



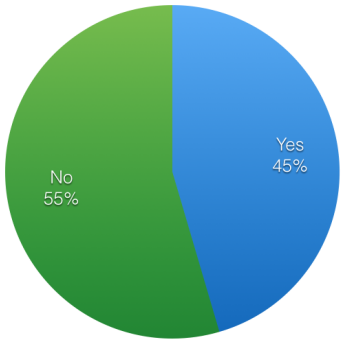
(a) Gender Distribution



(b) Studies



(c) Get's Easily Motion Sick



(d) Has Tried Oculus Rift Before

Figure 11.1: Participant Overview - Presence Test

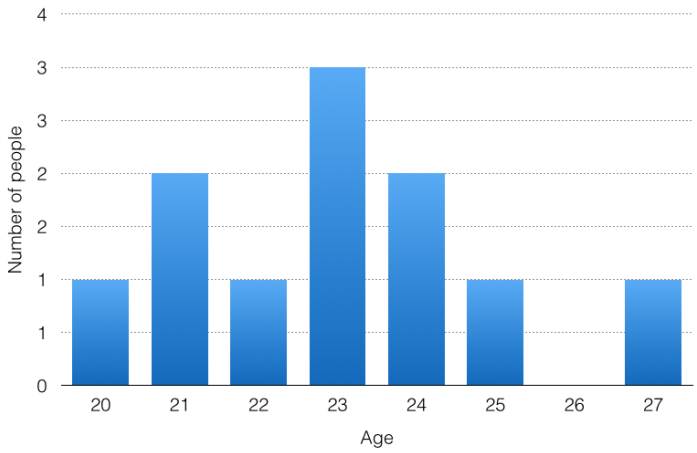


Figure 11.2: Age Distribution - Presence Test

11.3 Location and Equipment

The conduction of the test was in a meeting room at the department of computer and information science, at The Norwegian University of Science and Technology (NTNU). The equipment used was the Oculus Rift, a headset, and a computer capable of running virtual reality simulations.

11.4 Test Procedure

The tests were conducted the 5. March. It was an individual session for each participant, and it lasted for about half an hour. During these tests, the ten-step guideline for usability testing (see Section 7.2) were used. However, it was modified to fit for this research project. Therefore, step 5 and 6 were not applicable. Additionally, since this test did not have particular usability tasks, there was no need for the participants to think aloud.

Similarly to a usability test, a pilot test was conducted before the presence tests started. The pilot test was done to make sure all equipment worked as supposed to, and discover possible weaknesses in the methodology in advance. It also gave practice performing the test.

In the beginning, there was an introduction of me as a facilitator, the purpose of the test, and what was going to happen. The participants were informed that they could abort the test at any time without further explanation. Furthermore, that the simulation was being tested, and not them. The participants were encouraged to ask if they had any questions, and to answer the questionnaires and interview questions as honest as possible. After this, participants signed a consent form stating that they agreed to conduct the test. This form can be seen in Appendix B. The participants also filled out a background information form, which can be seen in Appendix C.

Next, the equipment and how the equipment worked was introduced. In addition, their expectations to the simulation were adapted, due to it only being a prototype. Then, the equipment was calibrated, and they were positioned correctly. Immediately after the first simulation had finished, the equipment were calibrated again, and then the second simulation was run. As mentioned previously, the first half of the participant tested the driver seat simulation first, and the second half tested the back seat simulation first.

After both simulations had been run, the participants filled out the presence questionnaire (see Appendix D) and the simulation sickness questionnaire (see Appendix E. Lastly, the semi-structured interview was conducted. It is possible to read the details in Section 9.1.

Finally, the test was wrapped up with final comments, and thanking the participants for their help with this research project.

11.5 Problems and Challenges

There were also some problems and challenges that occurred during the test. One issue that was directly related to the Oculus Rift. Since the Oculus Rift is only a development kit, and it is still in beta testing, there were some instabilities.

Sometimes the Oculus runtime would not start. Other times the entire program crashed during the simulation. In the latter case, the simulation had to be restarted, and the calibration process had to be repeated. Furthermore, During the calibration process the Oculus sensor has to locate the Oculus Rift, and during this process the participant had to sit completely still; else the simulation would crash.

The second issue was also related to the Oculus Rift. As mentioned in Section 10.2, the position of the camera rig decides the starting point of the user when putting on the Oculus Rift. However, after calibrating the Oculus Rift, the participants did not necessarily end up in the same position. Since the participants had different heights, there were some variations in the starting position. Therefore, after the Oculus Rift was calibrated, the participant was placed in the car by physically adjusting the position of their chair. Moreover, the placement of the camera rig differed in the two simulations. As a result, this process had to be done twice, which was time-consuming.

12 | Results - Presence Test

This chapter presents the results of the presence test. First, the results of the presence questionnaire are presented, then, the results of the simulation sickness questionnaire. Next, the results from the semi-structured interviews are described. Lastly, there is a summary of the issues, both critical and non-critical.

12.1 Presence Questionnaire

These are the results from the presence questionnaire. The numbers in the first column represent the respective questions from the questionnaire (see Appendix D). It is also possible to see the all the topics from the questionnaire in the list below. This list also determines if a higher or lower average score is better for the questions.

Presence: Q1, higher score is better.

Awareness/immersion: Q2 - Q5, lower score is better.

Realism: Q6 - Q12, higher score is better.

Distractions: Q13 - Q14, lower score is better.

Engagement and involvement: Q15 - Q17, higher score is better.

Sounds: Q18 - Q20, higher score is better.

Feelings and reactions: Q21, higher score is better.

Question #	Average	StDev	Alpha	Confidence	Lower	Upper
Q1	4.14	0.64	0.05	0.38	3.76	4.52
Q2	2.27	1.19	0.05	0.7	1.57	2.97
Q3	2	1.18	0.05	0.7	1.3	2.7
Q4	1.77	1.08	0.05	0.64	1.13	2.41
Q5	2.05	1.19	0.05	0.7	1.35	2.75
Q6	3.36	0.81	0.05	0.48	2.88	3.84
Q7	4.55	0.52	0.05	0.31	4.24	4.86
Q8	3.36	0.81	0.05	0.48	2.88	3.84
Q9	3.18	0.6	0.05	0.35	2.83	3.53
Q10	3.5	1.07	0.05	0.63	2.87	4.13
Q11	3.45	1.13	0.05	0.67	2.78	4.12
Q12	3.68	0.46	0.05	0.27	3.41	3.95
Q13	2.45	0.82	0.05	0.48	1.97	2.93
Q14	1.55	0.69	0.05	0.41	1.14	1.96
Q15	3.91	0.54	0.05	0.32	3.59	4.23
Q16	4.05	0.47	0.05	0.28	3.77	4.33
Q17	3.77	0.41	0.05	0.24	3.53	4.01
Q18	4.36	0.92	0.05	0.54	3.82	4.9
Q19	4.18	1.08	0.05	0.64	3.54	4.82
Q20	4.55	0.69	0.05	0.41	4.14	4.96
Q21	4.09	0.66	0.05	0.39	3.7	4.48

Table 12.1: Scores Presence Questionnaire

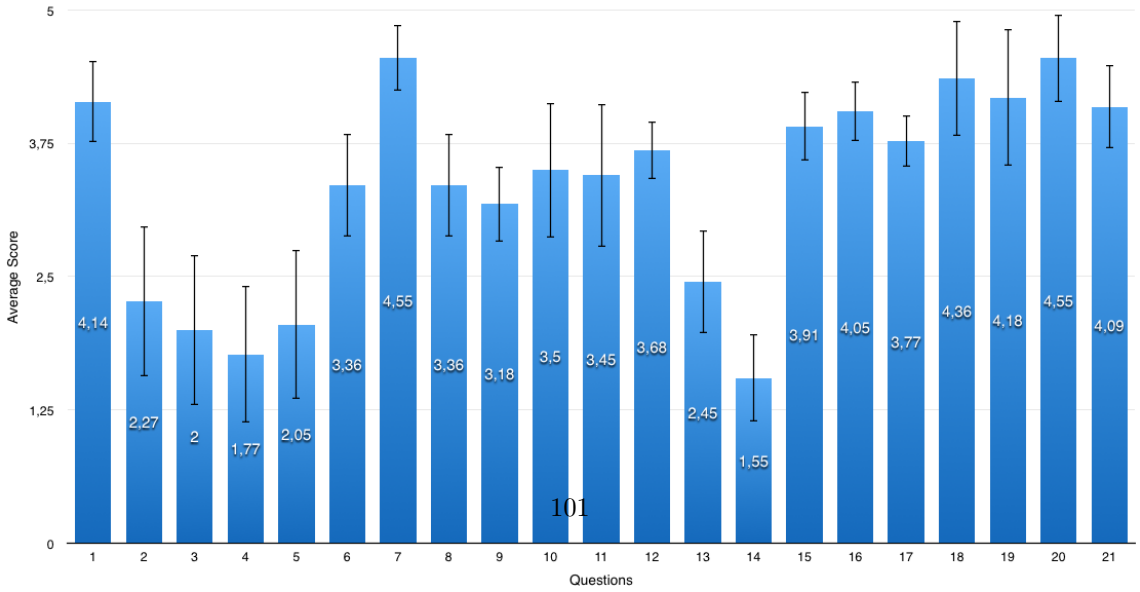


Figure 12.1: Average Scores on PQ

In summary:

- The presence topic got a score significantly above the average score on the scale (i.e. 3). A higher score was better.
- The awareness/immersion topic got all scores lower than average the average limit. A lower score was better.
- The realism topic got all scores above average. However, Q9, regarding the driving flow, was just slightly above the average limit. A higher score was better.
- The distraction topic got both scores below average. However, Q13, concerning the visual quality, was slightly below average. A lower score was better.
- The engagement and involvement topic got all of the scores significantly above average. A higher score was better.
- The sound topic got all the scores significantly above average. A higher was better.
- The feelings and reaction topic also got scores significantly above average on the scale. A higher score was better.

12.2 Simulation Sickness Questionnaire

This section contains the results from the simulation sickness questionnaire. Below is a list of all the symptoms related to simulation sickness. The questionnaire covered all of them. This list will be used as a reference back to each symptom.

1. **General discomfort**
2. **Fatigue**
3. **Headache**
4. **Eye strain**
5. **Difficulty focusing**
6. **Salivation increasing**
7. **Sweating**
8. **Nausea**
9. **Difficulty concentrating**
10. **Vertigo**
11. **Blurred vision**

12. **Dizziness with eyes open**
13. **Dizziness with eyes closed**
14. **«Fullness of the Head»**
15. **Stomach awareness**
16. **Burping**

Table 12.2 shows the total number of participants who chose the distinct alternatives (i.e. none, slight, moderate, severe) per symptom. The results are also shown graphically in Figure 12.2.

Symptom	**None**	**Slight**	**Moderate**	**Severe**	**Total**
General discomfort	8	2	1	0	11
Fatigue	10	1	0	0	11
Headache	10	1	0	0	11
Eye strain	7	3	1	0	11
Difficulty focusing	9	1	1	0	11
Salivation increasing	10	1	0	0	11
Sweating	11	0	0	0	11
Nausea	10	0	1	0	11
Difficulty concentrating	8	3	0	0	11
Vertigo	7	3	1	0	11
Blurred vision	9	1	1	0	11
Dizziness with eyes open	8	2	1	0	11
Dizziness with eyes closed	9	1	1	0	11
«Fullness of the Head»	11	0	0	0	11
Stomach awareness	9	1	0	0	11
Burping	11	0	0	0	11

Table 12.2: Results SSQ

It is possible to see that none of the participants experienced any severe case of any of the symptoms. For the most part the they did not experience any symptoms. However, there were a few symptoms experienced slightly or moderate. In, Figure 12.2 the numbers on the x-axis represents the respective number from the list of symptoms, which can be seen at the top of this section.

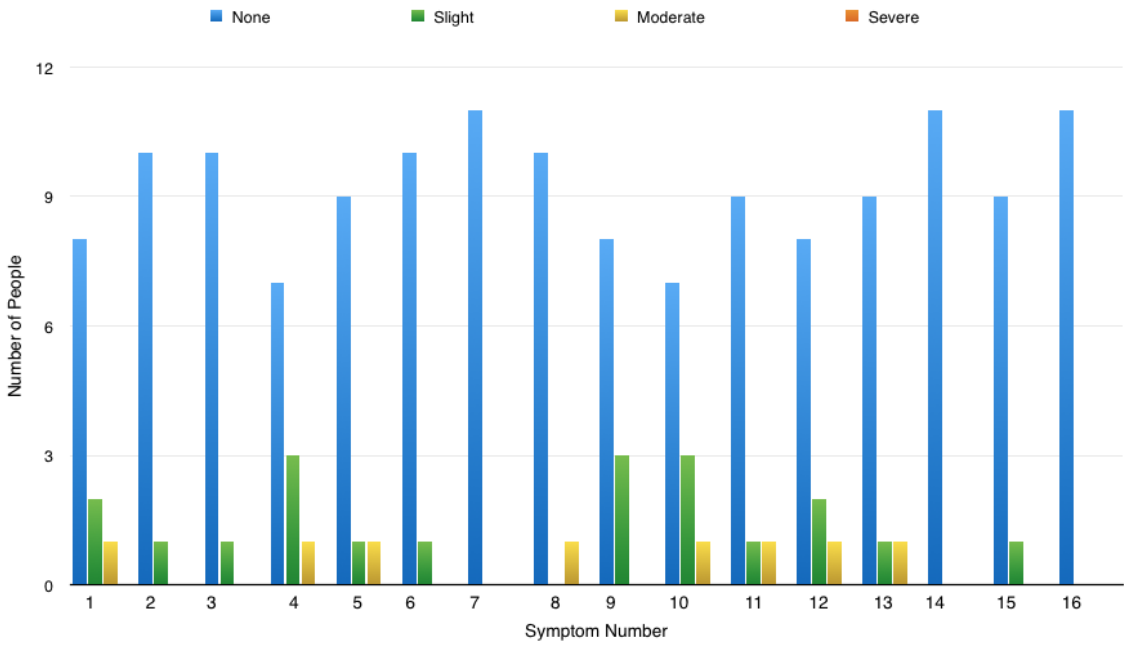


Figure 12.2: Results SSQ

Table 12.3 shows the average scores, standard deviation, and confidence interval for each symptom. The numbers in the top most row are the respective number from the list of symptoms from the top of this section. The scale went from 0-3, where zero represent none, and 3 represent severe. It is possible to a graphical representation in Figure 12.3.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Average	0.36	0.09	0.09	0.45	0.27	0.09	0	0.18	0.27	0.45	0.27	0.36	0.27	0	0.27	0
StDev	0.67	0.3	0.3	0.69	0.65	0.3	0	0.6	0.47	0.69	0.65	0.67	0.65	0	0.65	0
Alpha	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Confidence	0.396	0.18	0.18	0.41	0.38	0.18	-	0.35	0.28	0.41	0.38	0.4	0.38	-	0.38	-
Upper	0.756	0.27	0.27	0.86	0.65	0.27	-	0.53	0.55	0.86	0.65	0.76	0.65	-	0.65	-
Lower	0	0	0	0.04	0	0	-	0	0	0.04	0	0	0	-	0	-

Table 12.3: Average Scores on SSQ

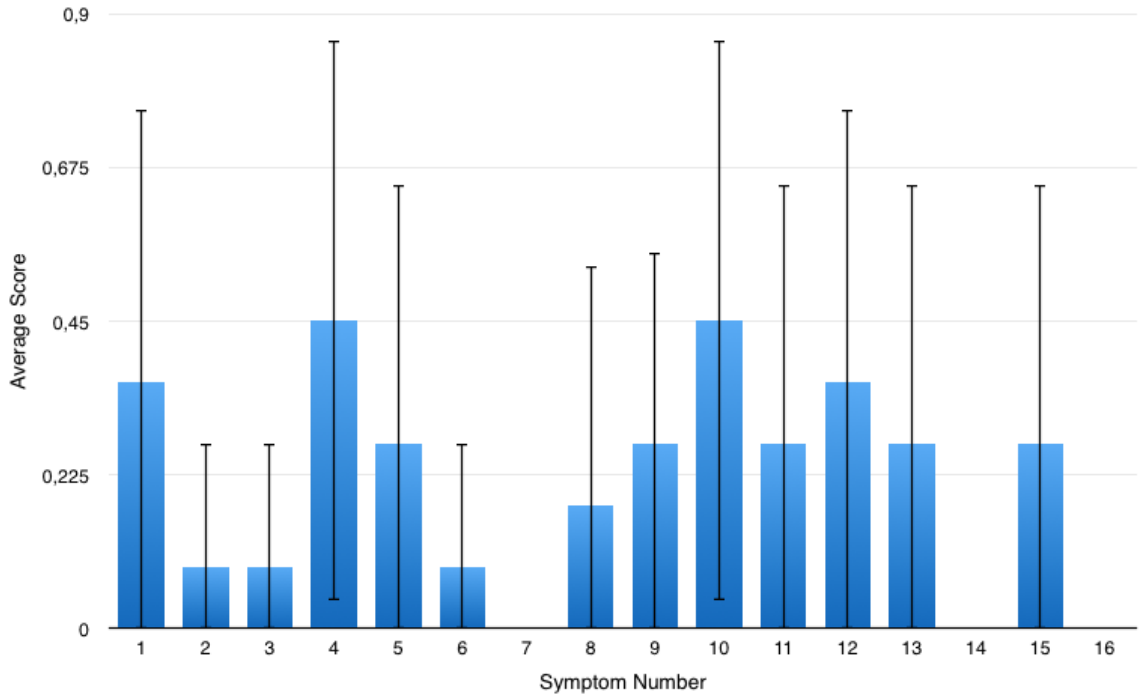


Figure 12.3: Average Scores SSQ

12.3 Semi-structured Interview

A qualitative analysis was conducted on the data gathered from the interviews (see Section 7.7.1). The categories of the analysis are based on the questions from the interview. It is possible to read more about the interview in Section 9.1.4.

First there is a summary of the most important parts of each category. Then there are some quotations to support and back up the summary.

- **Desired version:**
  There were two different versions of the simulation. One where the participants were located in the driver seat, and another where they were in the backseat. 90% of the participant liked the driver seat version best. It was because the driver seat version made them more aware of the collision, due to the increased ability to observe more from that position. Moreover, they felt more immersed in the simulation in the driver seat version.

  P03: *In the driver seat version it was possible to see more, which made me more immersed in the simulation.*

  P06: *The driver seat version made me want to grab the steering wheel to avoid the collision.*

P08: *The driver seat version was best because it gave a feeling of responsibility because I was the driver.*

P05: *The driver seat version was best because it gave a really uncomfortable feeling of not having control.*

- **Sounds:**
  The participants had some comments on the sound. They experienced that the sound was too loud and that it was a little unnatural.

  P02: *It sounded like the car drove at too high revs.*

  P09: *The sound coming from the car were a little loud.*

  P10: *It was possible to hear that car only drove in one gear, which was a bit unnatural.*

- **The driving route:**
  The participants also had comments regarding the driving. They felt like the turns were a bit sharp. However, they liked the driving route in general.

  P04: *The turns could have been more natural, they were a bit sharp.*

  P11: *There could have been a better driving flow during the turns.*

  P01: *I liked that there were pedestrians in the city as well. It made the simulation seem more realistic.*

  P04: *I thought it was clever to have me drive a bit before the collision because it showed how easy it could be to lose control.*

  P06: *The driving route had just the right length.*

- **The moment before the collision:**
  The participant's liked the moment before the accident, due to the creation of a moment showing how easy it is to lose control. Further, they felt it created a powerful moment where there was no way to avoid the collision with the bus, and this was something that they had to accept.

  P09: *I got freaked out at the moment right before the collision. I wanted to hit the brakes and stop the car.*

  P02: *I thought it was clever to have the users discover the bus when it was too late because that is how it can be in real life.*

  P03: *I thought the simulation generated a clear message stating that one does not always have control, especially the moment right before the collision.*

  P07: *At first I liked when the car accelerated, but when I saw the bus I thought oh no, and panicked. It was a powerful moment.*

  P06: *I thought it was smart that it was a collision with a bus because it shows how serious it can be.*

- **The moment after the collision:**
  The participants also had comments on the moment right after the collision. They felt like it did not reflect the seriousness of a traffic accident. The situation did not accurately show consequences of a crash. Also, they expected physical actions that matched what they saw visually.

P11: *The collision felt a little weird because I expected to be smashed, but I was not.*

P10: *The crash felt like "bumper cars". I think the crash sound should have been more intense.*

P01: *I expected blood, fire, smoke and unconscious people after the accident, and because this was not the case. I felt calmer than I should have after a collision.*

P05: *I expected more smoke and explosions, and to see more of the consequences of the accident.*

12.4 Issues

As mentioned previously, this research project used two levels of issues: critical and non-critical errors. This section describes the issues that were discovered by the presence test.

12.4.1 Critical Errors

Critical errors are in this research project defined as issues that significantly lowers the experience of presence and immersion in the simulation. Also, it is issues that generate severe symptoms of simulation sickness. The goal of the simulation was to have no critical errors.

The simulation did not have any critical errors. It is possible to see from Figure 12.1 that the average score on the first question (i.e. the experience of presence) is above average. It is also possible to see from Figure 12.2 that there were no severe cases of any symptom of simulation sickness. In addition, all the participants were able to complete the test.

12.4.2 Non-critical Errors

Non-critical errors are in this research project defined as minor problems that slightly lowers the experience of presence or immersion. Unfortunately, there were some non-critical issues.

First of all the sound from the car was a bit unnatural. Also, the subjective measures suggested that the collision sound needed to be more intense. Secondly, the turns needed to get a better and more natural driving flow. Lastly, the moment after the crash needed to be improved to make sure that the collision is not calming for the participants. All of these issues were used to make some final changes to the simulation, and it is possible to read about them in Section 10.8.

Part VI

Research Procedure and Results: Persuasive Test

13 | Research Procedure - Persuasive Test

This chapter describes the research procedure for the persuasive test. For this test the qualitative and quantitative methods mentioned in Section9.2 were used. The first two sections describes the planning and recruitment phase. The next sections describe the participants, the location and the equipment required. Lastly, the test procedure will be described, as well as the problems and challenges with conduction the test.

13.1 Planning

A test plan was created during the planning phase to be prepared for the persuasive test. The test plan included the goals of the test. The first goal was to discover the persuasiveness of each of the medias. The second goal was to reveal which media was the most persuasive. Lastly, to identify possible positive or negative factor related to behavior change regarding such medias.

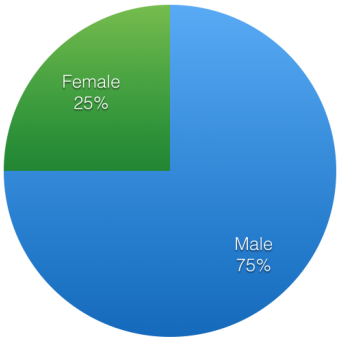
In the planning phase, the attitude, behavior, and perception questionnaires were prepared. In addition, the guide for the card ranking method was created. Lastly, all the interview guides were made during the planning phase. The details of these methods can be seen in Section 9.2.

The test plan also included practical information about the test: when and where. It also included the equipment needed to conduct the test. Furthermore, it included a step-by-step plan for the conduction.

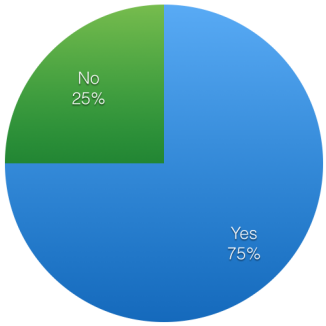
Lastly, the test plan included measurable objectives to be able to evaluate the simulation. It is possible to read the details of the test plan in Appendix G.

13.2 Recruitment and Participants

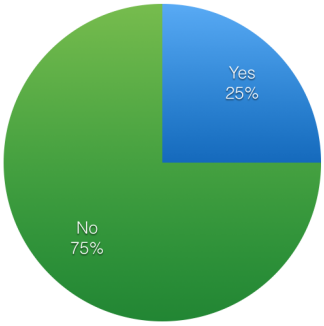
Since the requirement to participate in this research project was to have previously played Real Life Auto, only participants from the pre-project were recruited. In the pre-project 13 teenagers were recruited from different high schools. However, only 8 were available the second time around. Below is an overview over the participant's and their background.



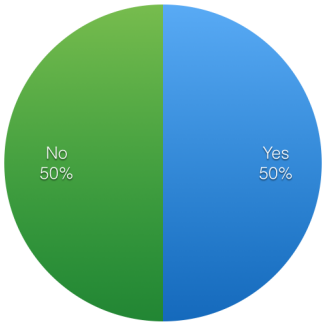
(a) Gender Distribution



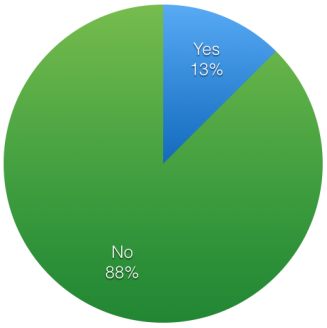
(b) Plays Computer Games Regularly



(c) Has Tried Oculus Rift Before



(d) Has a Drivers Licence



(e) Has Experienced a Traffic Accident

Figure 13.1: Participant Overview - Persuasive Test

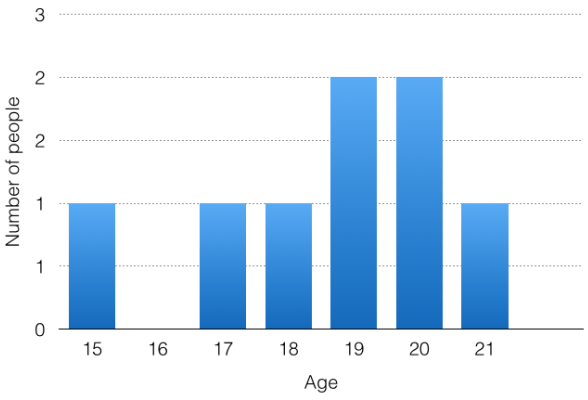


Figure 13.2: Age Distribution - Persuasive Test

13.3 Location and Equipment

The tests were conducted in the usability laboratory at NESP (Norwegian Center for Electronic Patient Journal), which is located at the Faculty of Medicine at NTNU in Trondheim. The laboratory gave a controlled environment for the experiment.

At the laboratory, there are two main rooms: the observation room and a test room. Since there was no "observer" in these tests, only the test room was used. It was equipped with video cameras and microphones to gather the data. In addition, the Oculus Rift, a headset, and a computer able to run virtual reality were also used (see Figure 13.3).

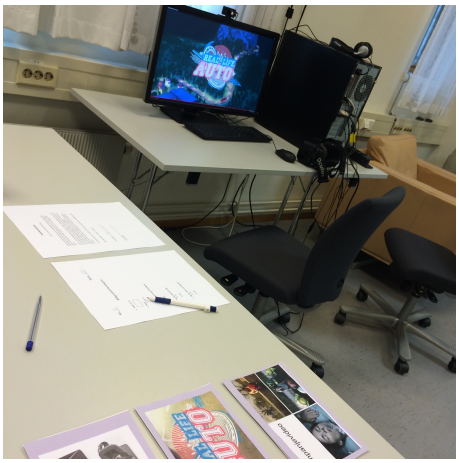


Figure 13.3: Equipment - Persuasive Test

13.4 Test Procedure

The tests were conducted in the period from 19. March to 29. March, 2015. Like the presence test, this was also an individual session for each participant, and it lasted for about an hour. During these tests, the ten-step guideline for usability testing (see Section 7.2) were used. However, it was modified to fit for this particular test. Therefore, step 5 and 6 were not applicable, due to the lack of specific usability tasks and thereby no need to think aloud.

A pilot test was conducted before the persuasive tests started. It was done with a fellow student to make sure all equipment worked as supposed to. Moreover, to discover possible weaknesses in the methodology in advance. It also gave practice performing the test.

When the participants arrived, there was an introduction of me as a facilitator, the purpose of the test, and what was going to happen throughout the test. The participants were informed that they could abort the test at any time without further explanation. Additionally, they were told that the different medias were being tested, and not them. They were also encouraged to ask if they had any questions, and to answer the questionnaires and interview questions as honest as possible.

After this, participants signed a consent form stating that they agreed to conduct the test. This form can be seen in Appendix H. The participants also filled out a background information form, which can be seen in Appendix I. Next, the equipment the equipment and how it worked were introduced. Moreover, their expectations to the different medias were adapted to fit the conditions of the medias.

Next, the participant watched the medias: the simulation, the campaign video and the introduction video made for Real Life Auto. This last video was shown to remind the participants of the game and all the elements of the game because it would have been time-consuming to have them play the game again.

As mentioned in Section 9.3, the order they tested the medias varied. However, immediately after the participant had tested a media, they filled out an attitude, behavior, and perception questionnaire regarding the media (see Appendix J). After that, the participants ranked each media according to which they thought had the most persuasive effect on teenagers regarding risky behavior in traffic (see Appendix K). The last part of the persuasive test was a semi-structured interview regarding all the medias (see Appendix L). It is possible to read all the details about each research method used during the persuasive test in Section 9.2.

Lastly, the test was wrapped up with final comments, and thanking the participants for their help with this research project.

13.5 Problems and Challenges

Problems and challenges also occurred during the persuasive test. As mentioned in Section 11.5, various challenges occurred, due to the Oculus Rift is still being in beta testing. The issues described in the presence test were also occurring in this test.

Another issue that came up was the number of participants attending. One of the requirements to participate was to have previously played Real Life Auto. Therefore, the number of participants to choose from was limited to the 13 from the preliminary project. Among them, 10 participants were recruited. However, due to other commitments two participants canceled, and the final number of participants was 8. Since there were only 8, the qualitative data becomes more important than the quantitative.

14 | Results - Persuasive Test

This chapter contains all the results of the persuasive test. First the results from the questionnaires are presented. Then, the results from the card ranking are described. The last section contains the qualitative results from the semi-structured interviews.

14.1 Attitude, Behavior, and Perception Questionnaires

This section presents the results from the questionnaires regarding attitude, behavior, and perception. The scores regarding each media is shown in the sections below.

14.1.1 The Simulation

These are the scores from the attitude, behavior and perception questionnaire regarding the OR simulation. First it is possible to see the total and average scores. Then, it is possible to see the results from the student t-test comparing how the participants evaluated themselves versus teenagers in general.

Metric	**Own Attitude**	**Teen's Attitude**
Total	26.5	29.0
Average	3.31	3.63
Standard deviation	1.03	0.69
Alpha	0.05	0.05
N	8	8
Confidence	0.71	0.48

Table 14.1: Scores on Attitude - The Simulation

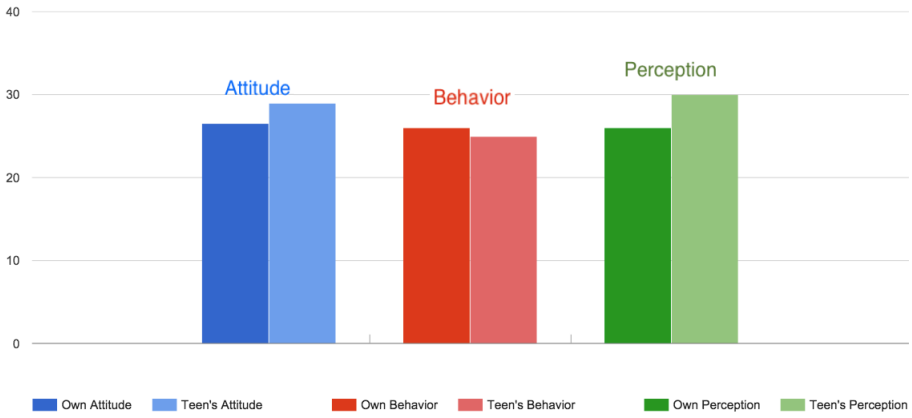
Metric	Own Behavior	Teen's Behavior
Total	26.5	25.0
Average	3.25	3.13
Standard deviation	1.28	0.64
Alpha	0.05	0.05
N	8	8
Confidence	0.89	0.44

Table 14.2: Scores on Behavior - The Simulation

Metric	Own Perception	Teen's Perception
Total	26.0	30.0
Average	3.25	3.75
Standard deviation	1.49	0.46
Alpha	0.05	0.05
N	8	8
Confidence	1.03	0.32

Table 14.3: Scores on Perception - The Simulation

(a) Average Scores - The Simulation



(b) Total Scores - Simulation

Figure 14.1: Scores on Attitude, Behavior and Perception - The Simulation

Results of the Student t-test:

- Attitude: p = 0.49
- Behavior: p = 0.80
- Perception: p = 0.38

It is possible to see that all the p-values are higher than the alpha = 0.05, which means that the participant's evaluation of themselves versus teenagers are not significantly different.

14.1.2 The Campaign Video

These are the scores from the attitude, behavior and perception questionnaire regarding the campaign video. First it is possible to see the total and average scores. Then, it is possible to see the results from the student t-test comparing how the participants evaluated themselves versus teenagers in general.

Metric	**Own Attitude**	**Teen's Attitude**
Total	28.0	28.0
Average	3.50	3.50
Standard deviation	1.07	0.76
Alpha	0.05	0.05
N	8	8
Confidence	0.74	0.52

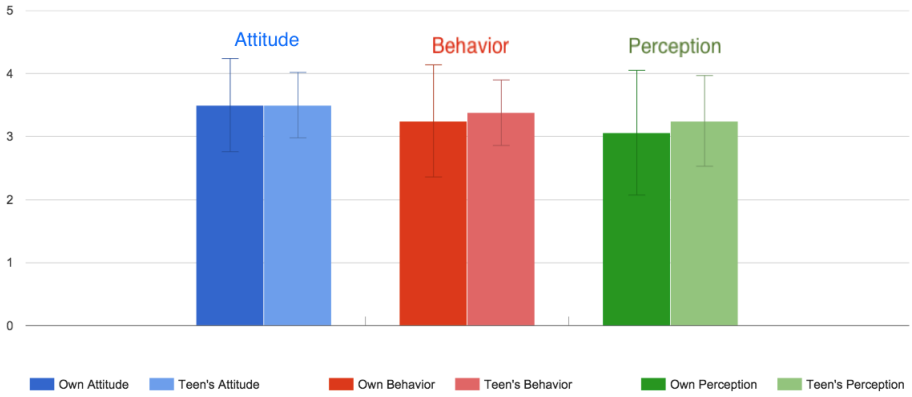
Table 14.4: Scores on Attitude - The Campaign Video

Metric	**Own Behavior**	**Teen's Behavior**
Total	24.5	26.0
Average	3.06	3.25
Standard deviation	1.43	1.04
Alpha	0.05	0.05
N	8	8
Confidence	0.99	0.72

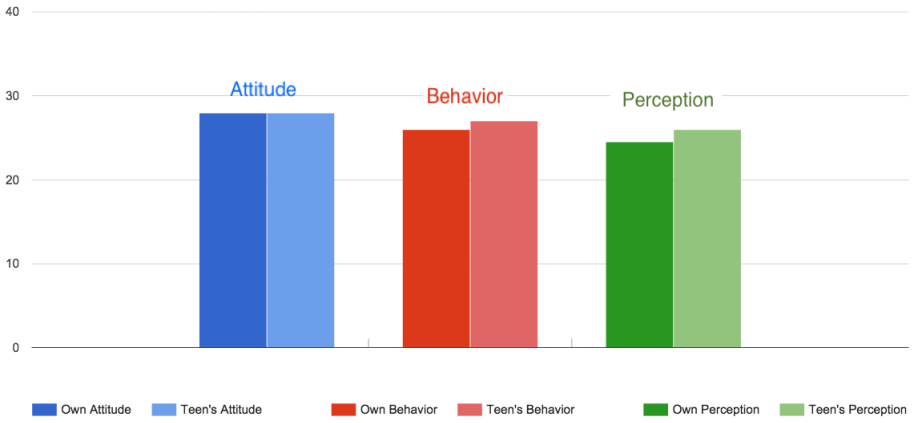
Table 14.5: Scores on Behavior - The Campaign Video

Metric	**Own Perception**	**Teen's Perception**
Total	26.0	30.0
Average	3.25	3.75
Standard deviation	1.49	0.46
Alpha	0.05	0.05
N	8	8
Confidence	1.03	0.32

Table 14.6: Scores on Perception - The Campaign Video



(a) Average Scores - The Campaign Video



(b) Total Scores - The Campaign Video

Figure 14.2: Scores on Attitude, Behavior and Perception - The Campaign Video

Results of the Student t-test:

- Attitude: p = 1
- Behavior: p = 0.81
- Perception: p = 0.77

It is possible to see that all the p-values are higher than the alpha = 0.05, which means that the participant's evaluation of themselves versus teenagers are not significantly different.

14.1.3 Real Life Auto

These are the scores from the attitude, behavior and perception questionnaire regarding Real Life Auto. First it is possible to see the total and average scores. Then, it is possible to see the results from the student t-test comparing how the participants evaluated themselves versus teenagers in general.

Metric	**Own Attitude**	**Teen's Attitude**
Total	27.0	27.0
Average	3.38	3.38
Standard deviation	1.06	0.74
Alpha	0.05	0.05
N	8	8
Confidence	0.73	0.51

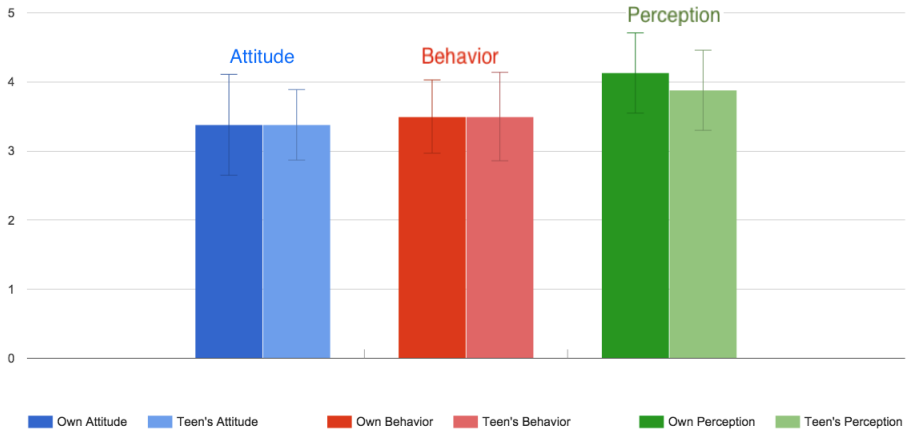
Table 14.7: Scores on Attitude - RLA

Metric	**Own Behavior**	**Teen's Behavior**
Total	28.0	28.0
Average	3.50	3.50
Standard deviation	0.76	0.93
Alpha	0.05	0.05
N	8	8
Confidence	0.53	0.64

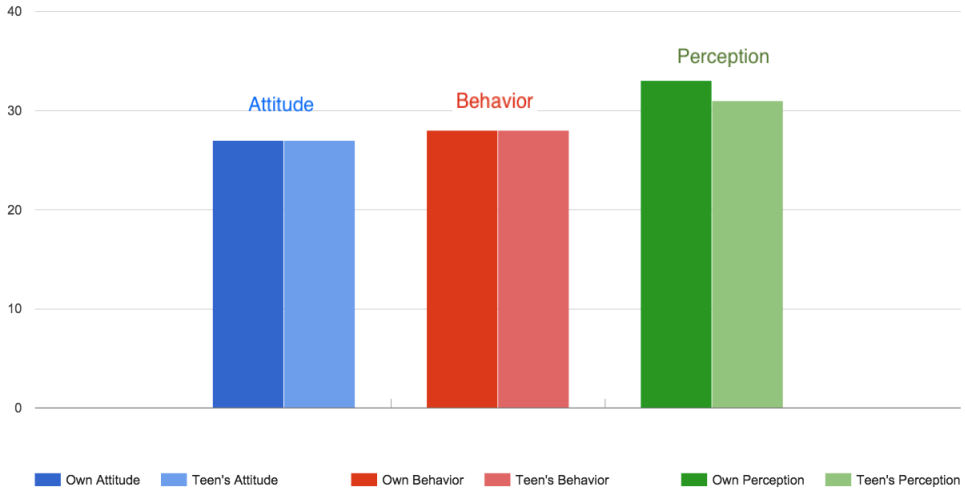
Table 14.8: Scores on Behavior - RLA

Metric	**Own Perception**	**Teen's Perception**
Total	33.0	33.0
Average	4.13	3.88
Standard deviation	0.83	0.83
Alpha	0.05	0.05
N	8	8
Confidence	0.58	0.58

Table 14.9: Scores on Perception - RLA



(a) Average Scores - RLA



(b) Total Scores - RLA

Figure 14.3: Scores on Attitude, Behavior and Perception - RLA

Results of the Student t-test:

- Attitude: p = 1
- Behavior: p = 1
- Perception: p = 0.56

It is possible to see that all the p-values are higher than the alpha = 0.05, which means that the participant's evaluation of themselves versus teenagers are not significantly different.

14.1.4 Validity of Real Life Auto

These are the results of the attitude, behavior and perception questionnaire conducted during the pre-project. Additionally, a student t-test was performed on these scores as a validity test. The results are presented below.

Metric	**Own Attitude**	**Teen's Attitude**
Total	36.50	36.00
Average	2.81	2.77
Standard deviation	1.25	1.01
Alpha	0.05	0.05
N	13	13
Confidence	0.68	0.55

Table 14.10: RLA's Scores on Attitude - Pre-project

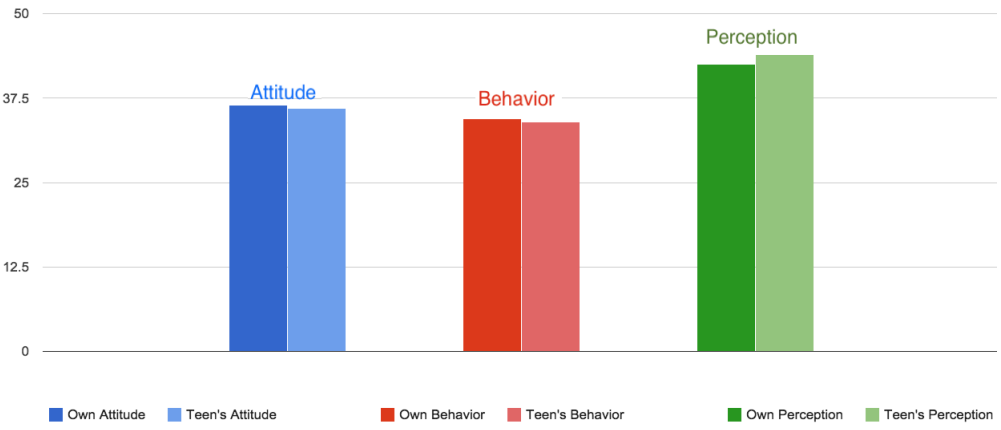
Metric	**Own Behavior**	**Teen's Behavior**
Total	34.50	34.00
Average	2.65	2.61
Standard deviation	1.40	1.06
Alpha	0.05	0.05
N	13	13
Confidence	0.76	0.58

Table 14.11: RLA's Scores on Behavior - Pre-project

Metric	**Own Perception**	**Teen's Perception**
Total	42.50	44.00
Average	3.27	3.38
Standard deviation	1.13	1.37
Alpha	0.05	0.05
N	13	13
Confidence	0.61	0.74

Table 14.12: RLA's Scores on Perception - Pre-project

(a) Average Scores on RLA - Pre-project



(b) Total Scores on RLA - Pre-project

Figure 14.4: Scores on Attitude, Behavior and Perception - Pre-project

Results of the Student t-test:

- **Attitude:**
  - Own: $p = 0.28$
  - Teenager's: $p = 0.16$
- **Behavior:**
  - Own: $p = 0.14$

- Teenager's: p = 0.06

- **Perception:**
  - Own: p = 0.08
  - Teenager's: p = 0.37

It is possible to see that all the p-values are higher than the alpha = 0.05. This means that the results from the pre-project were not significantly different from the results from this research project.

14.1.5 Comparing the Medias

A final student t-test was conducted to compare the scores of the three medias. The purpose was to reveal if there was any significant difference between them. Since there were three different medias, they were all tested against each other, and the results can be seen below.

- **Attitude:**
  - Own:
    1. Simulation vs Campaign video: p = 0.72.
    2. Campaign video vs RLA: p = 0.82.
    3. RLA vs Simulation: p = 0.90.
  - Teenager's:
    1. Simulation vs Campaign video: p = 0.74.
    2. Campaign video vs RLA: p = 0.74.
    3. RLA vs Simulation: p = 0.49.

- **Behavior:**
  - Own:
    1. Simulation vs Campaign video: p = 1.
    2. Campaign video vs RLA: p = 0.64.
    3. RLA vs Simulation: p = 0.64. .
  - Teenager's:
    1. Simulation vs Campaign video: p = 0.48.
    2. Campaign video vs RLA: p = 0.77.
    3. RLA vs Simulation: p = 0.36.

- **Perception:**
  - Own:
    1. Simulation vs Campaign video: p = 0.80.
    2. Campaign video vs RLA: p = 0.09.

3. RLA vs Simulation: p = 0.16.

– Teenager's:

1. Simulation vs Campaign video: p = 0.23.
2. Campaign video vs RLA: p = 0.20.
3. RLA vs Simulation: p = 0.31.

It is possible to see that all the p-values are higher than the alpha = 0.05, which means that none of the results above are significantly different. As an example, the participants evaluated to which extent they thought that both the simulation and the campaign video would change their own attitude, but comparing these results shows that there is no significant difference.

14.2 Card Ranking

This section presents the results from the card ranking. The first section gives an overview over the quantitative results, and the second sections show the qualitative results.

14.2.1 Quantitative Results

It is possible to see the rankings in Table 14.13. The average rank for each media was calculated from the orderings the participants conducted. The score was given either 1, 2 or 3, where 3 was the highest ranked. It is possible to see the average scores in Table 14.14.

Participants	**Highest Ranked**	**Middle Ranked**	**Lowest Ranked**
ID01	O	R	C
ID02	R	O	C
ID03	O	C	R
ID04	O	C	R
ID05	O	C	R
ID06	O	R	C
ID07	C	O	R
ID08	O	R	C

Table 14.13: Ranking of Medias

The letters C, O, and R, each represent one of the medias as follows:

- **C** - The campaign video. The campaign video is described in detail in Section 5.2.
- **O** - The Oculus Rift simulation. It is possible to read more about the simulation in Chapter 10.
- **R** - Real Life Auto computer game. More details about Real Life Auto can be seen in Section 5.1.

Media	Average Rank
The Simulation	2.75
The Campaign Video	1.63
Real Life Auto	1.63

Table 14.14: Average Scores from Card Ranking

Figure 14.2.1, shows a graphical representation of the average scores. The calculation of the confidence interval used the values of alpha=0.05 and n=8.

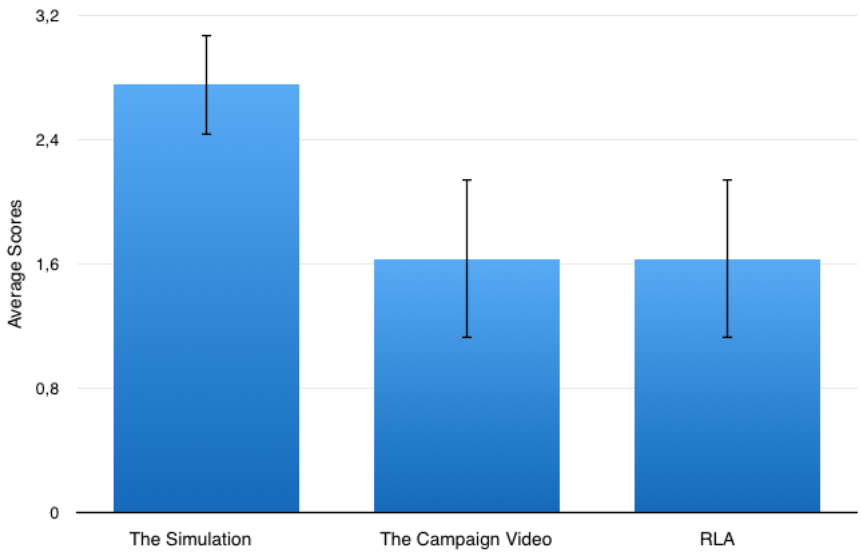


Figure 14.5: Average Scores from Card Ranking

A Friedman test was conducted to analyze the data from the card ranking. A Friedman test is similar to the ANOVA test, but it is suited for ranked data. The test gave a power value of p = 0.01. This p-value means that the result is statistically significant, which means the simulation is considered to be more efficient regarding persuasiveness compared to the other medias. However, there was no significant difference between the campaign video and RLA.

14.2.2 Qualitative Results

Additionally, the participants were asked to explain why they ranked the medias as they did. Below the results are presented. First there is a summary for each media. Then there are some quotations to support and back up the summaries.

- **The Simulation:**
  The participant though the idea of experiencing a traffic accident from a first person view was persuasive and memorable. In general, they felt such an experience was more persuasive compared to watching a video, or playing an educational computer game. Furthermore, they though immersion and presence were crucial factors for persuasion. In addition, they thought emotional content should be added to the end of the simulation because they considered emotional content to be more persuasive than educational content. Lastly, the participants commented that the simulation was a little predictable, but that was because of the situation of use.

  - **Persuasion through presence and immersion:**
    The participants liked the concept of experiencing a traffic accident from a first-person point of view. They felt more present and immersed in the situation, which felt made it more persuasive than the other medias.

    ID03: *This simulation brought me really close to the situation, and being in the situation makes it more persuasive.*

    ID06: *The concept is close to reality, and that makes it more persuasive than the other medias.*

    ID08: *The feeling of being in the car, seeing, hearing and experiencing the accident is more persuasive compared to the other medias.*

    ID04: *The simulation was the most persuasive because you can't just look away. If I turned my head I was still sitting in the car.*

  - **Persuasion through emotional content:**
    The participant mentioned that presence and immersion are powerful for persuasion. Additionally, they thought emotional content was important, moreover, even more important than educational content. Therefore, they felt the simulation could be improved by adding more consequences of an accident at the end of the simulation. They thought such changes to the simulation would make it change both attitudes and behaviors.

    ID04: *I think it would be more persuasive to add more negative consequences of a collision at the end. Then it would be extremely impactful and memorable.*

    ID07: *Add more animations at the end to make it even better, because the concept of experiencing a traffic accident first person is very persuasive.*

    ID08: *I think emotional content is more persuasive than educational content like RLA. The simulation would change both attitudes and behaviors if the ending had contained more emotional consequences.*

- **The Campaign Video**
  The participants considered the campaign video to have a relatively high level of emotional content, which made an impression on them. Additionally, they thought it showed fatal consequences of speeding. Moreover, they thought it visualized well what might happen to other people involved. Unfortunately, they though the impression would not last particularly long, and therefore they considered the simulation to be more persuasive.

  ID05: *I could feel a pinch in my stomach during the video. However, it is not the worst campaign video I have seen.*

ID01: *The video clearly showed how many people might get affected by traffic accidents.*

ID06: *I definitely felt bad for the people involved, but I think I will forget most of it soon.*

ID07: *I do not think it helps regarding behavior change, but maybe it changes attitudes.*

ID08: *The video is not memorable over time. Therefore, I think the simulation is more persuasive.*

ID02: *The simulation could also be thought of as a campaign video, only it is more realistic.*

- **RLA:**
  The participants thought RLA contained some quality educational videos. However, they did not believe it was suited for the target users. They experienced it as childish, messy and not particularly interactive. Furthermore, they thought there was a relatively large gap between other games created for them as target users compared to RLA. They suggested that a new improved version of the game should be created, however, only for younger users. They thought it would be a good idea to start generating proper attitudes at an early age.

  ID01: *I liked some of the videos in RLA. However, it is not videos that go viral.*

  ID03: *The game is not suited for the target users. It is too childish and messy.*

  ID07: *The game was not very interactive, and I do not think it will change my attitude or behavior.*

  ID08: *It s not suited for the target users because there is a huge difference between RLA and other games.*

  ID05: *I think it could be used for kids to start working with good attitudes at an early age. However, some of the content has to be changed. Also, it should be modernized.*

  ID04: *I do not think it is persuasive because it is more educational and not based on emotions.*

14.3 Semi-structured Interviews

This section presents the results from the semi-structures interviews regarding each media. The first section contains the results regarding the simulation and the second presents the results regarding the campaign video. Next, the results regarding RLA are presented. The last section shows the results from the final questions about how the participants would solve the problem of persuading teenagers to avoid risky behavior in traffic. The interview guides can be seen in Appendix L.

14.3.1 The Simulation

In this section, the results from the interviews regarding the simulation are presented. They are separated into several categories, and each contains a related summary. Lastly, there are some quotes from the participants to back up the summary.

- **Presence and immersion:**
  The participants thought a media trying to persuade adolescents to take fewer risks in traffic, needs to be immersive and involving to do that. Moreover, they felt very present and immersed in the simulation even though it was just a prototype.

ID03: *I felt like a part of the simulation. It felt like it was happening to me.*

ID07: *I felt so immersed that I stepped my foot down trying to hit the brakes.*

ID04: *The simulation seemed so real that I forgot about the physical surroundings.*

ID05: *Right before the collision I wanted to grab the steering wheel and hit the brakes.*

ID01: *Even though I did not feel anything physically, still, seeing it visually was very unpleasant.*

ID03: *If there were more emotional content in the end, watching the simulation would be a thousand times more effective than a campaign video.*

- **Persuasiveness:**
  The participants thought the simulation could persuade teenagers to change attitudes and behaviors. Especially, if adding more emotional content was to the end of the simulation. The reason they considered it to be persuasive was because it gave an insight into a possible reality, and it made them felt uncomfortable even though they knew the simulation was not real. It reminded them that this is not something they want to experience again. The main reason for why they thought the simulation was so persuasive was because it is possible to get very immersed in it. The participants discussed how immersion and presence create memorable emotions that can shake you up. They explained that such emotion might flash back when they are out driving, and therefore they thought it could change not only teenagers attitudes, but also their behaviors.

  ID01: *It was very persuasive because it gave an uncomfortable feeling even though I knew it was not real.*

  ID01: *This simulation made me think that I do not want to experience that scary feeling of not having control again.*

  ID05: *The reason I think it is persuasive is because it gives an insight to what might actually happen, and I do not want to experience it in real life.*

  ID02: *I think the simulation hits people really hard is because they can see it for them self.*

  ID04: *I think that the simulation is very effective because in the simulation it actually happens to you.*

  ID06: *Immersion is very persuasive because it is very memorable. I think those who tries the simulation will remember that uncomfortable feeling when they are driving.*

  ID07: *I believe that the simulation can change both attitudes and behavior because they will remember the feeling they had during the simulation and try to avoid getting the feeling again.*

- **Improvements:**
  The participants thought the simulation was powerful. However, they mentioned some improvement potential. First, the graphics could be improved. Secondly, they felt there could be more content showing consequences of a traffic accident at the end. Lastly, they wanted more life and traffic in the city.

  ID08: *I think more people and traffic in the city would improve the simulation because it would make it more realistic.*

ID03: *I would like to see what happened after the collision. Having the screen turned black as if I died was fine, but I think it would be more effective to show the consequences.*

ID07: *The graphics could be better because some of the content was slightly blurry. However, I am still surprised about how advanced the technology was. The details on the dashboard was incredible.*

- **Predictability:**
  Since the participant were asked to take part in a research project, the participant expected something to happen during the simulation. Therefore, they were very observant during the simulation and expected there to be an accident.

  ID01: *The simulation was a little predictable.*

  ID05: *Since this is a research project I expected something like this to happen.*

  ID07: *Even though I expected something to happen, I thought the car would stop in time, so I was a bit surprised.*

- **Future usage:**
  The participants had several suggestions for future usage. First, they felt like such a simulation was something everyone should experience before getting the drivers license. Moreover, they thought a good idea would be to do it at the "basic traffics course". Regarding future usage, the participants suggested creating a similar simulation for typical situations a teenagers might get. They also proposed to create driving simulations. Driving simulation could be used to practice driving, understand different signs and checking blind zones. Lastly, they suggested creating a simulation teaching about speed and braking distance.

  ID06: *I think everyone should experience a simulation like this before being allowed to take the drivers license.*

  ID01: *I think a simulation like this should be mandatory in the basic traffics course.*

  ID08: *I think there should be several simulations showing the worst outcomes of many different situations that teenagers often get in.*

  ID02: *It would be great to use this technology to create a driving simulation, where it is possible to practice driving and learn the meaning of different signs.*

  ID04: *A simulation like this could also be used to teach teenagers about braking distance because it is something everyone has heard of, but it is hard to imagine. I think visualizing it would be very useful.*

14.3.2 The Campaign Video

In this section, the results from the interviews regarding the campaign video are presented. The results are separated into several categories, and each category has a related summary. Lastly, there are some quotes from the participants to back up the summary.

- **Presence and immersion**
  The participants thought the content in the video was emotional, and it made them feel slight

compassion for the people involved. However, they did not feel connected to the situation. Additionally, they said that teenagers today plays violent games, watch violence in movies, on TV, the internet, and the news. Therefore, they believe that campaign videos should be brutal and powerful to have an effect. However, at the same time it has to feel realistic, and this campaign video seemed exaggerated and staged.

ID06: *I felt some compassion for the people in the video, especially when the girl visited her boyfriends grave, but at the same time the whole situation was a little bit exaggerated.*

ID07: *I felt like the situation was so exaggerated that it made me feel disconnected to it, so I figured that it won't happen to me.*

ID04: *Teenagers today are used to see a lot of violence, so I think we get more and more immune to it. Therefore, it is important that the content seems realistic.*

ID03: *Because teenagers play violent games, watch violent movies, I think that campaign video needs to be brutal, but at the same time it needs to be realistic.*

- **Persuasiveness**
  The participants did not feel that the campaign video was particularly influential regarding behavior change. However, they thought the video gave them a new perspective. On the other hand, they did not consider it to be particularly memorable, due to exaggerating in the video. They thought it could change attitudes slightly, but they doubted that it would change any behaviors.

  ID01: *The video gave me a new perspective because it showed consequences for other people. However, because it felt a bit staged and unreal I do not think it was very persuasive.*

  ID06: *I do not think I will remember this video for very long, so it ca probably help changing attitudes, but I do not think it can change behaviors.*

14.3.3 Real Life Auto

In this section, the results from the interviews regarding the RLA are presented. They are separated into several categories, and then a summary of the category are presented. Lastly, there are some quotes from the participants to back up the summary.

- **Presence and immersion**
  The participants did not feel immersed in Real Life Auto. In fact, they did not think the game was involving at all. However, they thought some of the videos in the game was a little engaging.

  ID04: *I was involved in the game, I felt like I was always just sitting and waiting.*

  ID01: *The game was not very engaging. However, some of the videos made me feel a little involved.*

  ID05: *The game was just okay; nothing less nothing more.*

- **Persuasiveness:**
  The participants did not think the game had a persuasive effect that could change adolescents risky behavior in traffic. They felt it was not catchy enough. Moreover, they felt it lacked a "shock factor", which gives a memorable uncomfortable feeling connected to traffic accidents. They thought the game was unsuited for the target users. Lastly, since the game was not immersive, they did not think it was persuasive.

  ID04: *I did not think the game is persuasive because it lacks a shock factor that makes the users feel uncomfortable.*

  ID03: *The game is not catching on, and therefore I do not think it will change any behaviors.*

  ID03: *The game needs to focus on emotional content rather than educational content to change behaviors.*

  ID07: *I do not think it is suited for teenagers. I this game would be a good start for younger kids to learn that the traffic is no game.*

  ID08: *I did not get very immersed in the game, and that is a must to change behavior.*

14.3.4 The Target Users' Solutions

In this section the results of the interviews regarding how the target users would solve the task of persuading adolescents to avoid risky behavior in traffic. First there is a summary of the results, then there are some quotes from the participants to back up the summary.

- **The adolescents' solution:**
  The participants were asked what they would do if they had this task. First, the participants suggested creating a new and better version of Real Life Auto for younger users. They explained that it was important to start creating better attitudes at an early age. However, to change adolescents' behavior, they would use a combination of campaign videos and Oculus Rift simulations. The campaign videos would have the benefit of reaching many people fast. Moreover, they would make the videos more realistic, detailed, immersive and shocking. Similarly, they would create a finished version of an OR simulation where the content would be shocking and memorable. They also wanted to create many simulations showing different scenarios teenagers can get in.

  ID06: *I would probably make a new improved version of RLA for younger users. I think it would help to teach about traffic safety at an early age.*

  ID05: *I would definitely focus on Oculus Rift simulations in order to change behaviors regarding traffic safety.*

  ID01: *In addition, create OR simulations, I think that creating campaign videos also should be done because they can be shared and reach many people fast on the internet.*

  ID07: *I would create powerful and memorable content for both the campaign videos and the OR simulations. In this way, they become more persuasive.*

Part VII

Discussion and Conclusion

15 | Discussion

This section discusses the results from the Chapters 12 and 14. There will be a discussion associated with to each of the research questions from Section 1.2.

15.1 Research Question 1 - Presence and Immersion:

Does the Oculus Rift simulation produce an experience of presence and immersion, such that the user feel it could be a real traffic accident?

Due to the relevance of presence and immersion while evaluating virtual reality simulations, it was important to answer this research question. If the target users do not feel present nor immersed in the simulation, consequently, it could be challenging to use it for persuasion.[13] (see Section 4.3). Therefore, presence and immersion were measured, and it was done by conducting a presence test. The answer to the question is based on the analysis of the data from this test.

A presence questionnaire gathered the data regarding presence and immersion, and the scale went from 1-5. Hence, the average limit is 3. The goal was to get average scores above this limit for positive statements, and below it for the negative (see Appendix A). It is possible to see the results from this questionnaire in Section 12.1.

It is possible to see that all topics formulated as positive statements got scores above the average limit: presence, realism, engagement and involvement, sounds and feelings and reactions. However, the realism topic only got scores slightly above average. As an example, question Q9 regarding the driving flow got an average score of 3.18. Consequently, the lower bound of the related confidence interval was below the average limit. Therefore, it is reasonable to assume that there might be some improvement potential regarding the driving flow. Furthermore, the topics formulated as negative statements got scores lower than the average limit: awareness/immersion and distractions. However, question Q13, regarding the visual quality of the simulation, got a score slightly below average. This result caused the lower bound of the related confidence interval to be below the average limit. Therefore, it is likely that there is some improvement potential regarding the graphics as well.

Additionally, a simulation sickness questionnaire was given to gather data. The purpose was to determine if the participants experienced any symptoms of simulation sickness. If the participants felt sick during the simulation, that could unfortunately decrease their experience of presence and

immersion. Therefore, this questionnaire asked about all the known symptoms related to simulation sickness, and to which extent the participants experienced them. Fortunately, the results (see Section 12.2) showed that no participants experienced any severe cases. Also, the average score for all symptoms were below 0.5, which is significantly lower than the average limit on the scale, 1.5. Based on these results, it is assumed that the simulation did not give the participants simulation sickness that significantly lowered their experience of presence and immersion.

Lastly, semi-structured interviews were conducted, and the results can be seen in Section 12.3. The results indicated that the participants assessed the simulation as a powerful media for persuasion. Especially the moment right before the collision made an impact on them. The reason was excellent visualization showing how quickly one can lose control. Additionally, they felt it showed the inevitability of certain situations. However, the results also indicated improvement potential. First, the participants thought the sound from the car could have been lowered and more realistic. Further, they experienced that the turns during the driving were a bit sharp. Therefore, the driving flow could be improved. It is possible to observe that these results are related to the findings from the presence questionnaire, where the average score on driving flow is only slightly above average. Lastly, the participants commented on the moment after the collision. They felt it did not reflect the seriousness of a traffic accident.

The goal of the presence test was to get no critical errors. It is possible to from Section 12.4 that this was achieved. However, there were some non-critical errors: the car sound, the driving flow and the moment after the collision not reflecting the seriousness of an accident. These issues were taken into consideration and improvements were made before the persuasive test. First, the car sound was lowered. Secondly, there were added more checkpoints during the turns to make it smoother. Lastly, the ending was modified so that the screen faded to black after the collision. It is possible to read the details about these improvements in Section 10.8.

Overall, these are positive results that indicate that is possible to create a simulation with such a high level of presence and immersion that gives an uncomfortable feeling connected to traffic accidents. It shows that it is possible to create an Oculus Rift simulation suited for persuasive purposes. However, it is necessary to specify that it is not scientifically proven that all Oculus Rift simulations are persuasive. It only shows that it is possible.

In summary:

- The simulation produced a high level of presence and immersion.
- Such a high degree of presence and immersion gave the users an uncomfortable feeling connected to traffic accidents.
- The positive results indicated that it is possible to design Oculus Rift simulations suited for persuasive purposes.

15.2 Research Question 2 - Persuasiveness:

How do the users assess the effect each of the medias, the simulation, the campaign video and RLA, has on attitude, behavior and perception change for both themselves and other teenagers?

This question addressed the target users' subjective assessments of each of the three medias' persuasive impact. The participants evaluated to which extent they believed these medias could change attitudes, behaviors, and perceptions. It was essential due to these factors relevance for persuasion (see Section 2.1). Moreover, they evaluated the impact on both themselves and teenagers in general. The answer is based on an analysis of the data collected by the attitude, behavior and perception questionnaire. Secondly, it is based on an analysis of the data from the semi-structured interviews. These results can be seen in Section 14.1 and 14.3. The next sections discuss the results regarding each media in detail.

However, the requirement to determine a media as persuasive was to get average scores above the average limit on the scale(i.e. 3). The scale was a 5-point Likert scale (i.e. strongly disagree to strongly agree). Therefore, the higher the average scores, the more the participants agrees that a media could change either attitude, behavior or perception towards taking fewer risks in traffic.

15.2.1 The Simulation

The results regarding attitude change showed that both average scores were above the average limit (themselves: 3.31, teenagers: 3.63). However, the lower bound (themselves) of the related confidence intervals was below this limit, which indicates some data uncertainty. Furthermore, it is possible to see that the score evaluating themselves was slightly less than the teenagers' score. However, the student t-test concluded that the scores were not significantly different.

The average scores addressing behavior change were slightly above the average limit (themselves: 3.25, teenagers: 3.13). However, the lower bounds of the related confidence intervals were slightly below it. Furthermore, it is possible to see that the average score assessing themselves was higher than the teenagers' score. On the other hand, the student t-test showed that there was no significant difference between the two groups.

The results regarding perception change also had average scores above the average limit (themselves: 3.25, teenagers: 3.75). The lower bound of the related confidence interval about themselves were below the average limit. However, it was above this limit on the teenagers' score. Unfortunately, the result of the student t-test showed that there was no significant difference between these groups either.

The results from the semi-structured interviews indicated that the participants thought the simulation could persuade teenagers to change attitudes and behaviors. The main reason for their assessment was due to the simulations ability to give an insight into a real experience of a traffic accident. They got immersed in the simulation to an extent that it made them feel uncomfortable. The participants thought that feeling could function as a reminder of a feeling they did not want do experience again. They explained that such emotions could generate flashbacks when driving, and thereby cause a change in both attitude and behavior. This result also supports the findings of the presence test, which indicated that the simulation produced presence and immersion and that it was possible to design a simulation suited for persuasive purposes. Lastly, since they considered emotional content as essential for persuasion, they felt such content should be added to the simulation as well.

When analyzing all the results, it is possible to observe a contrast between the quantitative and the qualitative results. The quantitative results showed that the target users could change both

their own and teenagers attitude, behavior and perception slightly. However, there were some data uncertainty connected to this outcome. On the other hand, the qualitative results indicated that the simulation could significantly persuade the target users to avoid risky behavior in traffic. However, since there were only 8 participants, the qualitative results were considered more valid. The fewer participants, the larger the confidence interval gets. Unfortunately, most of the lower bounds were below the average limit.

In summary:

- The quantitative results showed a slight attitude, behavior, and perception change. However, there were some data uncertainty.
- The qualitative indicated a significant change in all three factors.
- The qualitative results were considered more valid than the quantitative results, due to the low number of participants.

15.2.2 The Campaign Video

The average attitude change scores were above the average limit (themselves: 3.50, teenagers: 3.50). However, the lower bounds of the confidence intervals were below this limit. Further, it is possible to see that the scores were equivalent. Also, the student t-test concluded that they were not significantly different.

The average scores addressing behavior change were slightly above the average limit (themselves: 3.06, teenagers: 3.25). Additionally, both lower bounds on the related confidence intervals were below this limit. Lastly, the student t-test concluded that there was no significant difference between themselves and teenagers.

The results regarding perception change also had average scores above the average limit (themselves: 3.25, teenagers: 3.75). The lower bound of the related confidence interval regarding themselves were below the average limit. However, the lower bound were above the limit for the teenagers' score. On the other hand, the results of the student t-test showed that there was no significant difference between the two groups.

The qualitative results regarding the campaign video indicated that it was not assessed particularly persuasive (i.e. persuading the target users to avoid risky behavior in traffic). Although it contained emotional content, which evaluated positively for persuasion, they did not feel connected to the situation. This was due to exaggeration and lack of a memorability factor. However, they thought it could change attitudes slightly, but they doubted it could change behaviors. Lastly, the participant believed campaign videos should be brutal and powerful, but not at the expense of realism. .

While investigating both quantitative and qualitative results, it is possible to discover similarities and differences. The quantitative showed that the target users could change attitude, behavior and perception slightly after watching the campaign video, but there were some data uncertainty. Similarly, the qualitative results indicated a slight attitude and perception change. However, the participants did not believe in a behavior change. Due to a low number of participants, the qualitative results were considered to be more reliable.

In summary:

- The quantitative results showed a slight attitude, behavior, and perception change. However, there were some data uncertainty.
- The qualitative results indicated a slight attitude and perception change, but no behavior change.
- The qualitative results were considered more valid than the quantitative results, due to the low number of participants.

15.2.3 Real Life Auto

Both average scores addressing attitude change were above the average limit (themselves: 3.38, teenagers: 3.38). Additionally, when investigating the lower bounds of the confidence intervals, the results shows that the scores were below the average limit, which indicates data uncertainty. Lastly, comparing these scores with a student t-test concluded that there was no significant difference.

The average scores regarding behavior change were above the average limit (themselves: 3.50, teenagers: 3.50). On the other hand, both lower bounds of the confidence intervals were below this limit. Also, the student t-test concluded that there was no significant difference between the two groups.

The results regarding perception change had average scores highly above the average limit (themselves: 4.13, teenagers: 3.88). Also, the lower bounds of the related confidence intervals were above the average limit. Lastly, the student-t test did not show a significant difference.

The qualitative results regarding the persuasiveness of RLA indicated that it was not considered particularly immersive nor involving. However, a few videos was found to be slightly engaging. Also, the participants thought the content was more educational than emotional. Both these reasons were the primary justifications for assessing RLA as not particularly persuasive. They felt it lacked a shock-factor that could work as a reminder in traffic. Additionally, they did not think the game was catchy enough. Lastly, they evaluated it to be unsuited for the target users.

When analyzing both quantitative and qualitative results, it is possible to detect a contrast. The quantitative results show that the game had a slight attitude and behavior change. However, there was some uncertainty in the data. In addition, the quantitative results showed a significant perception change. On the other hand, the qualitative results, indicated the game was not particularly persuasive. Since there were only 8 participants, the qualitative results influence the conclusion heavier than the quantitative. Additionally, it is possible to see a potential relation in the results. The participants considered the game to be educational, which could correspond to the high average score on perception change. However, a possible explanation could be that they believed the content were well suited for younger users.

Lastly, the quantitative results from the pre-project also showed a slight attitude and behavior change. The conclusion was that either a new version of the game or an entirely new game was needed, for it to obtain a persuasive effect. A student t-test showed that these results were not significantly different from the findings of this study, which increases the validity of this study.

In summary:

- The quantitative results showed a minor attitude and behavior change. However, there was

some data uncertainty.

- The quantitative results showed a significant perception change.
- The qualitative results indicated an attitude and perception change. However, no behavior change.
- The qualitative results were considered more valid than the quantitative results, due to a low number of participants.
- The results of pre-project were similar, and not statistically different from these findings.

15.3 Research Question 3 - A Comparison:

Comparing the simulation, the campaign video and Real Life Auto, which media is considered more effective regarding behavior change?

This question compared the Oculus Rift simulation, the campaign video, and Real Life Auto. The goal was to reveal which media the target users determined as the most persuasive (i.e. persuading the target users to avoid risky behavior in traffic). The answer to this question is based on the quantitative analysis of the data from the attitude, behavior and perception questionnaire, where all the medias were compared (see Section 14.1.5). It is also based on the analysis of the quantitative data from the card ranking (see Section 14.2).

The results from the attitude, behavior, and presence questionnaire were compared with a student t-test. This test concluded that there was no significant difference between the medias. On the other hand, the quantitative data from the card ranking showed that the simulation was considered to have the most persuasive effect on the target users (average score: 2.75). The campaign video and RLA were equally ranked (average scores: 1.63). The Friedman test showed that it was a statistically significant difference; the simulation was considered to be more persuasive than the other medias. However, there was no significant difference between the campaign video and Real Life Auto.

In summary:

- The t-test conducted on the attitude, behavior, and perception questionnaire concluded that there were no significant differences between the medias.
- The results of the card ranking showed a significant difference between the simulation and the other medias.
- The card ranking showed no significant difference between the campaign video and RLA.

15.4 Research Question 4 - Persuasive Factors:

What factors of the three media do the target users assess to have a positive or negative effect on behavior change?

This last question aimed to discover possible factors of the three media that had a positive or negative impact on persuasion (i.e. persuading the target users to avoid risky behavior in traffic). The question is answered based on the target users' reasoning behind their ranking of the medias (see Section 14.2). Additionally, it is answered based on the analysis of the qualitative data from the semi-structured interviews (see Section 14.3).

The analysis of the data indicated that the simulation was the most persuasive media, due to its ability to produce a first-person experience of a traffic accident. Such an experience was assessed more impactful compared to watching a video or playing a computer game, and among the primary influential factors were presence and immersion. Furthermore, this simulation did not contain driving interactivity. Therefore, it was no data to draw conclusions regarding this aspect.

Another factor having a positive impact on persuasion was emotional content. Hence, in a finished version the participants wanted more emotion at the end of the simulation showing consequences of an accident. The campaign video also contained emotional content. However, exaggeration made it appear unrealistic. Consequently, it was ranked lower than the simulation. Additionally, RLA were lower ranked than the simulation. However, the campaign video and RLA were ranked equally. The latter was assessed less persuasive than the simulation, due to lack of memorable content. Also, the educational content was not determined as persuasive. Moreover, it was evaluated as unsuited for the target users.

In summary: These are the factors that positively and negatively affect behavior change on the target users:

- **Positive:**
  - Presence
  - Immersion
  - A first-person experience
  - Emotional content
  - Memorability
  - Realism
- **Negative:**
  - Educational content
  - Content not suited for the target users
  - Exaggeration
  - Unrealistic content

Even though the campaign video and RLA were not considered as persuasive as the simulation, the participants did not recommend to drop these ideas. They suggested creating a new improved version of RLA for younger users. Preventive measures could be helpful in a long term perspective. Additionally, they thought campaign videos should be used, due to their ability to reach several people fast. Also, new powerful and realistic videos could help improving at least attitudes. However, they believed the primary focus for achieving behavior change should be an immersive Oculus Rift simulation with powerful and realistic content.

15.5 Final Discussion

Since the previous sections focus on discussing the results directly related to each of the research questions, this sections tries to gather other loose ends related to the study.

Today, the Oculus Rift technology is relatively new and revolutionary compared to other technologies. There exist other virtual reality goggles. However, they are expensive and mainly used for particular purposes. Moreover, they are quite expensive. The Oculus Rift has a reasonable prize, and it is overall accessible for people. Most of the participants had never experienced anything comparable to it, which could create an extra exciting experience for them. However, in a five years perspective, this technology could be relatively common. Thereby, not being as exciting as it was to this date. It is not guaranteed that such a simulation would have the same effect later.

Secondly, if a fully working Oculus Rift simulation were to be developed, a discussion of how it should be used in practice would be necessary. Several participants suggested that it could be used as a mandatory part of taking the drivers licence at traffic schools. That is a good idea since it can be tough for some people to learn from only verbal explanations (e.g. braking distance and reaction time). Such virtual reality simulations can visualize these situations. Moreover, due to the generation of presence and immersion, a simulation could make it more memorable.

A last relevant discussion is the persuasive influence of mild fear. The participants felt the Oculus Rift simulation created a moment before the collision that gave them an uncomfortable feeling connected to traffic accident. This feeling was not something they wanted to experience again, and they thought it could function as a reminder in real traffic. They believed this feeling could influence them to not take risks. It is important to notice that the persuasive power is based on mild fear. Having people traumatized could have an adverse effect. Therefore, it is essential to evaluate carefully what is considered mild fear when designing such simulations.

16 | Research Questions Relation to Each Other

When discussing the results a strong connection between all the research questions were found, and it is described below.

The discussion regarding the first research question indicated that the simulation immersed the users and made them feel present. The results showed that it was possible to create OR simulations suited for persuasive purposes. In the second question, the users assessed the persuasiveness of each of the three medias. The results indicated that only the simulation could change both behavior and attitude, which is strongly correlated with the first question. Further, the third question compared the persuasive effect of all the medias. The results concluded that the simulation was considered the most influential, which is strongly related to all the previous questions. Lastly, the result of the fourth research question indicated that the simulation was the most persuasive media, due to the experience of presence and immersion. Also, these findings strongly correlate with the other results. Such a significant coherence between the research conducted in this study increases the validity (see Chapter 18).

17 | Research in Relation to Prior Theory

This chapter addresses the results of this research project in relation to the prior theory presented in the background chapters.

One of the connections discovered was that virtual reality can be used for persuasive purposes. According to [12], virtual reality is suited as a persuasive tool. Similarly, the results from this research project indicated that it is possible to design a simulation suited for persuasion.

Next, research by [58] concluded that VR that focus on emotional intensity feedback could be powerful when it comes to persuasion. Likewise, the results of this study indicated that memorable and emotional content in VR simulations is essential for persuasion.

Additionally, according to [57] emotion plays an influential role when it comes to risk perception; negative emotion heightens the perception of risk. When the perception of risk as feelings becomes instinctive and intuitive, they form attitudes and behaviors. Therefore, negative messages that appeal to mild fear has shown to be an effective strategy when it comes to persuasion [58]. Strongly related, the results from this research indicated that mild fear can be suited to change behaviors. The participants experienced such an uncomfortable feeling that they believed it to be memorable enough to change their behavior. However, there is a vital distinction between mild fear and traumatization. The latter could result in unintended actions instead for a wanted behavior.

According to [32], credibility is considered essential for persuasion. Similarly, the results of this research indicated that credibility was crucial since the campaign video was evaluated less persuasive compared to the simulation, due to lack of credibility.

Lastly, a relation was found that connected the research from Sintef with this research project. The Sintef report indicated that experiencing an accident had a persuasive effect [11]. Closely related, the results of this study also suggested that experiencing a simulated traffic accident was considered to have a persuasive effect. Moreover, this persuasiveness was considered significantly more powerful compared to watching a traffic accident on video.

18 | Validity

This chapter discusses the results from this research project in relation to validity. It will be addressed in terms of objectivity, internal validity, external validity and ecological validity.

18.1 Objectivity

As mentioned in Section 8.1, objectivity is the degree to which the research is free of researcher bias and distortions.

In this research projects, two different tests were conducted: a presence test and a persuasive test. At the end of each test, semi-structured interviews were conducted. According to [69] there are many advantages of using interviews as a data gathering method (e.g. flexibility and dealing with topics in depth and detail). However, [69] also mentions some disadvantages. One of the disadvantages is the lack of reliability, which means that the influence of the researcher and the context might lead to inconsistencies. Such inconsistencies could make it difficult to achieve objectivity, and objectivity is essential to the validity of the research. Additionally, interviews can also be misleading and artificial. If an interviewee knows that they are speaking on the record, they may find a recorder or video recorder inhibiting, which might create a false impression. Furthermore, the researcher runs the risk of contracting knowledge that is not there, and such situations might decrease the objectivity and consequently the validity of the research.

An extensive video recording was made during the persuasive test to obtain the best possible objectivity. The videos made it possible to analyze if the participants were influenced by the facilitator. Another measure to achieve objectivity was making sure that the participants felt as comfortable as possible with the recordings. The equipment were not forced in their faces, but rather placed naturally with the rest of the equipment. Furthermore, the participants were informed that the recordings would not be published without their consent. Lastly, extensive notes were taken to obtain objectivity in the presence test.

Another challenge with such research experiment settings is the possibility of the participants wanting to be a "good participant", rather than being completely honest. However, the participants appeared comfortable and sincere in their responses. On the other hand, it is difficult to completely eliminate the influence of the facilitator.

18.2 Internal Validity

Presence is an important concept when it comes to virtual reality because it is strongly related to VR quality (see Section 3.2). Therefore, a presence questionnaire was created, and it was based on literature and existing presence questionnaires. Furthermore, it included statements regarding the relevant factors: presence, immersion, realism, distractions, engagement and involvement. However, there are many discussions regarding the definition of presence and how to measure it. Unfortunately, there are no standard methods. The criteria of how a presence questionnaires ideally should be states that presence should not be assumed by asking a participant how present they feel (see Section 3.6). Therefore, this test can only highly indicate that the simulation produces a high level of presence. However, it is not scientifically proven, which reduces the internal validity to some degree.

The simulation sickness questionnaire was also created based on the literature and existing questionnaires. It intended to discover if the simulation made the participants feel sick. If this were the case, then that could reduce the sense of presence. In an attempt to reduce the threats to internal validity, known quantitative methods were used to analyze the data regarding both questionnaires. Additionally, known qualitative methods were used to analyze the data from the semi-structured interviews.

To reduce the threat to internal validity regarding the attitude, behavior, and perception questionnaires, they were created based on the persuasive technology literature. As mentioned in Section 2.1, attitude, behavior and perception are fundamental concepts of persuasion. Also, they are strongly correlated. On the contrary, the questionnaires and interviews could have included more, but shorter and concise questions. The purpose would be to assure that all every sentence was expressed identically. Furthermore, to obtain internal validity, the results were analyzed by using known quantitative methods. Additionally, the results regarding Real Life Auto were compared to the results from the pre-project to discover any significant difference. However, there was no difference, which increases the validity.

During the card ranking the participants were informed in detail what they were ranking the medias according to; which media they considered to be most effective in persuading adolescents to change their risky behavior in traffic. It was done to make sure that all participants did the ranking from the same point of view. Also, the scores from the card ranking were statistically analyzed with known methods. Lastly, the participants explanations of the ranking orders were analyzed with established qualitative methods.

Furthermore, to reduce the threat to internal validity, the questions in the semi-structured interviews were based on the literature (both persuasive technology and virtual reality). Unfortunately, it could be confusing for a participant with no expertise in these research areas. Nevertheless, basing this research on the literature increases the internal validity, and it makes sure that the research remains as intended. Furthermore, each interview guide asked about the same topics to be able to compare the medias. All the results were analyzed with known qualitative methods. Additionally, since there were only eight participants during the persuasive test, the qualitative results were considered more relevant compared.

This research project uses the participant's subjective evaluations to measure the persuasive effect of the medias (i.e. the simulation, the campaign video and RLA). However, even if the results

show the medias persuades, or that one media is more persuasive compared to another, this is not being scientifically proven. These findings are only subjective evaluations of what they think their behavior would be, not a measurement of the actual behavior. That means the result can only indicate that they some positive or negative effect on behavior change.

Lastly, despite both age and gender differences, the conversations was perceived as mutual understanding between me as the facilitator and the participants. A possible explanation could be to the one-to-one test situation. Additionally, they had met me before, and they seemed relatively comfortable. However, a one-to-group situation (e.g. focus groups) could have created a researcher bias since there is an entirely different dynamic in a group of adolescents, compared to a conversation with only one.

18.3 External Validity

As mentioned in Section 8.3, external validity is the degree to which findings are generalizable to different people, settings, and times and depends on how representative the research samples are.

It is important to address if the chosen participants represent the target users (see Section 1.3). All participants recruited for this research project were recruited as volunteers. Therefore, they might be more enthusiastic and engaged compared to others. That makes it questionable if they represent all the target users. Furthermore, only 8 participants might be a too small sample to make generalizations about the target users.

18.4 Ecological Validity

As mentioned in Section 8.4, the ecological validity of a study means that the methods, materials and the setting of the study must approximate the real-world that is being examined.

Both experiments were conducted in controlled environments. However, the context of use for the simulation in the real world is not in a laboratory. This situation of use was not optimal. Many of the participants commented that joining a research experiment concerning traffic safety made them expect an accident or an almost accident to happen during the simulation. However, the focus was on testing the medias rather than the correct situation of use. In the real world, the situation of use could be at a traffic station, at school, or at home. Additionally, the context of use for the campaign video and RLA would also have been at home. On the other hand, the context of use for RLA could also have been at school. Unfortunately, due to time constraints, the participant's did not play RLA again in this research project. They only watched the teaser video to refresh their memory about the content of the game.

The social environment also had improvement potential. If the participants had tried the simulation at a traffic station there might have been an employee present. However, if the participants were at home, there would probably not be an observer present. Therefore, the social environment could have been better. A different social environment could have produced a stronger or lower reaction toward the simulation or the campaign video. In addition, during a real world experience of RLA, the participants might have made different choices in the game causing different end results.

The equipment was almost the same as used in a real world experience. To play RLA or watch the campaign video, the participants would only need a laptop and an internet connection. To run the simulation they would have needed a laptop able to run VR content, and many adolescents have laptops equipped to do it. The difference, however, is that the participants would probably not have done video recordings. In summary, both hardware and software were similar to a real world experience.

Considering the materials of the study, they were slightly different to what they would have been at home. First, the simulation was a prototype. The content in a complete version would have been more detailed and realistic. The content in the campaign video would have been the same. However, there also exists other campaign videos. Lastly, the content of the RLA, was exactly the same as a real-world experience. Even though the content was not exactly the same for all medias, the focus was on testing the potential of the medias rather than the exact content.

19 | Conclusion

Since adolescents are significantly over-represented in traffic accidents, this master thesis explores how technology can persuade them to avoid risky behavior in traffic. An Oculus Rift simulation was created because the results from the pre-project indicated that adolescents would not change unless they experienced an accident themselves. Therefore, the first part of the research was concerned with discovering if such simulations were suited for persuasive purposes. Then, three medias (the OR simulation, a campaign video, and the computer game Real Life Auto) were evaluated to determine if they had a persuasive effect. Also, these medias were ranked according to their persuasive impact on the target users. Lastly, the goal was to reveal positive or negative factors essential for persuasion. Due to time constraints, and the fact that behavior change is difficult to measure, the results are based on the target user's subjective evaluations.

This research project consisted of two main parts. The first part was a presence test. This test intended to explore the possibilities of designing a simulation suited for persuasive purposes, due the close relation between presence and persuasion. If the users do not feel immersed and present in a simulation, then it could also be challenging to persuade them (see Section 4.3). The data gathered during the presence test (using a presence questionnaire, a simulation sickness questionnaire, and semi-structured interviews) answered the first research question regarding presence. The results indicated that it is possible to create a simulation suited for persuasive purposes. The simulation designed for this particular research project had such a high level of presence and immersion that it gave the users an uncomfortable feeling connected to traffic accidents. Furthermore, they believed that experience could function as a reminder later. These positive result suggests that such simulations can be used for persuasive purposes. However, it is necessary to specify that it does not prove that all Oculus Rift simulations are persuasive.

The second part of this research project was a persuasive test. The results of this test were used to answer the last research questions. The second research question aimed to discover the target users subjective assessments regarding each of the three medias persuasive impact on attitude, behavior and perception change. They evaluated the impact on both themselves and teenagers in general. The answer was based on quantitative and qualitative analysis of questionnaires and semi-structured interviews.

The result indicated that the simulation could significantly persuade the target users to avoid risky behavior in traffic. The reason the participants believed it was persuasive was due to its ability to give a first-person the experience of an accident. Moreover, they got immersed to an extent that gave them an uncomfortable connected to traffic accidents. They believed this feeling could flash back when driving, and thereby causing them to change both their attitude and behavior. However,

they wanted more consequences and emotional content to the end of the simulation for it to be even more persuasive.

The result regarding the campaign video showed it was not particularly persuasive. The participants did not feel connected to the situation in the video due to exaggeration. Additionally, it was not memorable enough. On the other hand, they felt it had the necessary emotional content. However, it needed to be more realistic. In conclusion, they believed it could change attitudes slightly, but they questioned the ability to change behaviors.

Real life Auto was not considered as particularly persuasive either. The issue was the computer game's lack of ability to immerse and involve the users. Except for a few engaging videos. In addition, it lacked the necessary emotional content, and a shock-factor that could function as a reminder. Lastly, they did not think the educational content was suited for the target users. However, they believed it could be suitable for younger users. Similar results were also found during the pre-project, which increased the validity of these findings.

The third research question aimed to rank the medias according to their persuasive impact on the target users. This question was answered by comparing the results from the attitude, behavior and perception questionnaires. Also, by analyzing the quantitative results of the card ranking. From the first questionnaire, the results did not show a significant difference between the medias. On the other hand, the results from the card ranking concluded that the simulation was the most effective for behavior change. Unfortunately, there was no significant difference between the campaign video and RLA.

The last research question intended to reveal possible positive or negative factors essential for the persuasive power of such medias (i.e. persuading the target users to avoid risky behavior in traffic). The analysis of the data from the card ranking and the semi-structured interviews were used to answer this question.

The results indicated that the simulation was the most persuasive media. However, there was no significant difference between the campaign video and RLA. The reason the simulation was considered to be more influential was due to its ability to give the users a first-person experience of a traffic accident. They believed such an experience was more convincing than just watching a video or playing a game. Also, they believed immersion and presence were essential factors. On the other hand, in a finished version they thought emotional content should be added to the end as well, due to their assessment of emotional content being essential for persuasion as well. Although the campaign video contained emotional content, it was considered less persuasive due to exaggeration, and thereby determined unrealistic. The reason RLA were found less persuasive than the simulation was because it used educational content instead of immersive memorable content. Also, the participants did not think it was suited for the target users.

The validity of the research was relatively high. First, there was a strong relation between the research questions. It was also an apparent connection linking the research to prior theory. Additionally, measures were done to make this research project as objective as possible (e.g. video recordings and extensive notes). Measures were also done to increase the internal validity (e.g. experiment methods created based on literature, using known analysis methods). Furthermore, the external validity of the research project (e.g. focusing on qualitative results due to a low participant number) was taken into account. Lastly, the ecological validity was relatively strong. However, there could be some improvements regarding the social environment.

Based on these results, it is possible to indicate that an Oculus Rift simulation is suited for persuasive purposes. Moreover, the simulation created in this research project was considered to be persuasive, and even more persuasive than the campaign video and Real Life Auto. It can be derived that a full version of the simulation should be developed. However, more emotional content showing consequences of an accident should be added to the ending. Additionally, even though the campaign video and RLA were not considered to be as persuasive as the simulation, it is not recommend to dismiss these ideas. It is possible to create a new improved version of RLA for younger users. Lastly, since campaign videos can reach several people fast, new videos with realistic and powerful content should be produced.

19.1 Further Work

Since it was concluded that the simulation was considered the most persuasive media, the next step should be to create a full version of the simulation with powerful and emotional content. Furthermore, the Oculus Rift technology could also be used to run interactive driving simulations.

Interesting further work could also be to conduct studies discovering factors that make emotional content seem realistic and believable. Such results could be used to create the ending of the simulation. Furthermore, it could be used to create new campaign videos.

Additionally, it would be interesting to do further research regarding the educational factor. This factor had a negative effect on persuasion. It would be interesting to determine concretely what such content contains. Also, since the educational factor indicated a negative impact on persuasion, further work could be to study new learning strategies.

Lastly, further work regarding Real Life Auto, could be to look for new solutions for the target users. Additionally, an improved version could be developed and customize it for younger users.

Bibliography

[1] Vaughan, G.Hogg, M. A. *Introduction to social psychology*, 2005.

[2] A. Stevenson. *Oxford Dictionary of English*. Oxford Dictionary of English. OUP Oxford, 2010.

[3] Francisco Luis Gutiérrez, Jose Luis Isla, José Luis González, and Andres Francisco Aparicio. New Trends in Interaction, Virtual Reality and Modeling. *Human-Computer Interaction Series*, pages 113–126, 2013.

[4] K.Y. Tam and S.Yb Ho. Web personalization as a persuasion strategy: An elaboration likelihood model perspective. 2005.

[5] B. J. Fogg. Persuasive Technologies. 1999.

[6] Witmer, Bob G. and Singer, Michael J. Measuring Presence in Virtual Environments: A Presence Questionnaire. 1998.

[7] Em Kolasinski. Simulator Sickness in Virtual Environments. 1995.

[8] Francisco Luis Gutiérrez, Jose Luis Isla, José Luis González, and Andres Francisco Aparicio. New Trends in Interaction, Virtual Reality and Modeling. *Human-Computer Interaction Series*, pages 113–126, 2013.

[9] http://http://www.tryggtrafikk.no.

[10] Nils Petter Gregersen. Tenåringer i trafikken. 2011.

[11] Dagfinn Moe, Marianne E Nordtømme, Liv Øvstedal, Isabelle Roche-Cerasi og Kristian Sakshaug. Hvem bruker ikke bilbelte - og hva er årsaken. *Sintef Teknologi og Samfunn - Transportforskning*, 2009.

[12] Luca Chittaro and Nicola Zangrando. *The Persuasive Power of Virtual Reality: Effects of Simulated Human Distress on Attitudes towards Fire Safety*. 2010.

[13] Kim, T., and Biocca, F. Telepresence via television: Two dimensions of telepresence may have different connections to memory and persuasion. *Journal Of Computer-Mediated Communcation*, 1997.

[14] B. J. Fogg. Persuasive Computers: Perspectives and Research Directions. 1997.

[15] K Reardon. Persuasion in Practice. 1991.

[16] P. Zimbardo and M. Leippe. The Psychology of Attitude Change and Social Influence. 1991.

[17] G.R Miller. On being persuaded: Some basic distinctions. the persuasion handbook: Developments in theory and practice. 2002.

[18] Fishbein, M and Ajzen,I. *Belief attitude, intention and behavior.* 1975.

[19] Fazio, RussellH. *How Do Attitudes Guide Behavior?* 1986.

[20] W.N. Schoenfeld and W.W.Cumming. Behavior and perception. 1962.

[21] Simons, Morreale, and Gronbeck. Persuasion in society. 2001.

[22] Reeves, B. andNass, C. The Media Equation: How people treat computers, television, and media like real people and places. 1996.

[23] B. J. Fogg. Persuasive technology: Using computers to change what we think and do. 2003.

[24] B. J. Fogg. Computers as persuasive social actors. 2001.

[25] Clifford Nass, Jonathan Steuer, and Ellen R. Tauber. Computers are social actors. 1994.

[26] B. J. Fogg. Captology: The study of computers as persuasive technologies. 1997.

[27] Harri Oinas-kukkonen, Marja Harjumaa, and Harri Oinas-kukkonen. Persuasive Systems Design : Key Issues , Process Model , and System Features. 2009.

[28] Marja Harjumaa and Harri Oinas-kukkonen. Persuasion Theories and IT Design. 2007.

[29] Bj Fogg. A behavior model for persuasive design. 2009.

[30] Bj J Fogg. Creating Persuasive Technologies : An Eight-Step Design Process. 2009.

[31] B J Fogg, Jonathan Marshall, Othman Laraki, Alex Osipovich, Chris Varma, Nicholas Fang, Jyoti Paul, Akshay Rangnekar, John Shon, Preeti Swani, Marissa Treinen, and Cordura Hall. What Makes Web Sites Credible? A Report on a Large Quantitative Study. *Sigchi*, 2001.

[32] B J Fogg and H Tseng. The Elements of Computer Credibility. 1999.

[33] B J Fogg, Cathy Soohoo, David R Danielson, Ellen R Tauber, and Design. How Do Users Evaluate the Credibility of Web Sites ? A Study with Over. 2003.

[34] Kim, J. and Moon, J.Y. Designing towards Towards Emotional Usability in Customer Interfaces: Trustworthiness of cyber-banking system interfaces. *Interactiong with computers, 10,1-29.*, 1997.

[35] Shelly Chaiken. Communicator Physical Attractiveness and Persuasion. 1979.

[36] K.L.Dion, E.Bersheid and E. Walster. What is beautiful is good. *Journal of Personality and Social Psychology, 24:285-290*, 1972.

[37] Cialdini R. B. Influence: Science and practice (Fourth Ed). 1993.

[38] H. Tajfel. Social Identity and Intergroup Relations. *Cambridge University Press*, 1982.

[39] Clifford Nass, B. J. Fogg, and Youngmee Moon. Can computers be teammates ? 1996.

[40] Elaine Chan and Jaideep Sengupta. Insincere Flattery Actually Works : A Dual Attitudes Perspective. 2010.

[41] Clifford Nass and B. J. Fogg. Silicon sycophants : the effects of computers that flatter. 1997.

[42] Clifford Nass and B. J. Fogg. How Users Reciprocate to Computers: An experiment that demonstrates behaviour change. 1997.

[43] Harri Oinas-kukkonen and Marja Harjumaa. A Systematic Framework for Designing and Evaluating Persuasive Systems. 2008.

[44] George Coates. Program from Invisible Site—a virtual sho. 1992.

[45] Jonathan Steuer. Defining Virtual Reality: Dimensions Determining Telepresence. 1992.

[46] F.P. Brooks. What's real about virtual reality? 1999.

[47] T.B. Sheridan. Musings on Telepresence and Virtual Presence. 1992.

[48] Barfield, W., Zeltzer, D., Sheridan, T. B., and Slater, M. Presence and performance within virtual environments. 1995.

[49] Treismann, M. Temporal discrimination and the indifference interval: Implications for a model of the "internal clock.". *Psychological Monographs*, 1963.

[50] a McMahan. Immersion, Engagement, and Presence. *The video game theory reader*, pages 67–86, 2003.

[51] Janet Murray. Hamlet on the Holodeck: The Future of Narrative in Cyberspace. 1997.

[52] M Slater and S Wilbur. A Framework for Immersive Virtual Environments (FIVE): Speculations on the Role of Presence in Virtual Environments. 1997.

[53] M Slater. Measuring presence: A response to the Witmer and Singer presence questionnaire. 1999.

[54] J van Baren and W IJsselsteijn. Deliverable 5 Measuring Presence : A Guide to Current Measurement Approaches. 2004.

[55] essiter, J., Freeman, J., Keogh, E., Davidoff, J. A cross-media presence questionnaire:The ITC-Sense of Presence Inventory. *Presence: Teleoperators & Virtual Environments*, pages 282–289, 2001.

[56] Baron, R.A., Branscombe, N.R., Byrne, D. 2009.

[57] Slovic, P. The Perception of Risk. 2000.

[58] Slovic, P., Peters, E. Perception and Affect. *Current Directions in Psychological Science 15*, pages 322–325, 2006.

[59] Giuseppe Riva, Fabrizia Mantovani, Claret Samantha Capideville, Alessandra Preziosa, Francesca Morganti, Daniela Villani, Andrea Gaggioli, Cristina Botella, and Mariano Alcañiz. Affective interactions using virtual reality: the link between presence and emotions. *Cyberpsychology & behavior : the impact of the Internet, multimedia and virtual reality on behavior and society*, 10:45–56, 2007.

[60] Taylor, S. E., and Thompson, S. C. Stalking the illusive "vividness" effect. *Psychological Review, 89*, page 155–181., 1982.

[61] Croft, R. G., Stimpson, D. V., Ross, W. L., Bray, R. M., and Breglio, V. J. Comparison of attitude changes elicited by live and videotape classroom presentations. *AV Communication Review, 17(3)*, page 315–321, 1969.

[62] Fazio, R. H., and Zanna, M. P. Attitudinal qualities relating to the strength of the attitude-behavior relationship. *Journal of Experimental Social Psychology, 14,*, page 398–408., 1978a.

[63] Wu, C., and Shaffer, D. R. Susceptibility to persuasive appeals as a function of source credibility and prior experience with the attitude object. *Journal of Personality and Social Psychology, 52(4)*, page 677–688, 1987.

[64] Rundmo, Torbjørn and Iversen, Hilde. Risk perception and driving behaviour among adolescents in two Norwegian counties before and after a traffic safety campaign. *Safety Science*, 42, 2004.

[65] C. Wohlin, P. Runeson, M. Host, C. Ohlsson, B. Regnell, and A. Wesslén. Experimentation in software engineering: an introduction. 2000.

[66] M.D Myers. Qualitative research in information systems. *Management Information Systems Quarterly*, 1997.

[67] D. Svanaes. Understanding interactivity: Steps to a phenomenology of human- computer interaction. 2000.

[68] C. Robson. Real world research: a resource for social scientists and practitioner- researchers. 2, 2002.

[69] B.J. Oates. *Researching information systems and computing.* Sage Publications limited., 2005.

[70] INTERNATIONAL Ergonomic requirements for office work with visual display terminals (VDTs). 1998.

[71] Joseph S Dumas and Jean E Fox. Usability testing: current practice and future directions. *The Human-computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, 2003.

[72] Bruce Tognazzini. *TOG on Interface.* Addison-Wesley Longman Publishing Co., 1992.

[73] M. Buchenau, I.S. Francisco, and J.F. Suri. Experience Prototyping. *Conference on Designing interactive systems: processes, practices, methods, and techniques*, 2000.

[74] Vertelney, L. and Curtis, G. Storyboards and sketch prototypes for rapid interface visualization. 1990.

[75] Verplank, W., Fulton, J., Black, A. and Moggridge, W. Observation and invention: The use of scenarios in interaction design. . 1993.

[76] Houde, S., Hill, C. What do prototypes prototype? 1997.

[77] Wong, Y.Y. Rough and ready prototypes: lessons from graphic design. 1992.

[78] M Beaudouin-Lafon and W Mackay. Prototyping tools and techniques. *The human-computer interaction handbook*, pages 1017–1039, 2003.

[79] H. Jahrami. Card sort methodology: An objective measure in rehabilitation research. 2012.

[80] Russell K Schutt. Investigating the social world: The process and practice of research. 2011.

[81] D. Svanaes and G. Seland. Putting the users center stage: role playing and low- fi prototyping enable end users to design mobile systems. *In Proceedings of the SIGCHI conference on Human factors in computing systems*, page 479–486, 2004.

[82] B.R. Worthen, W.R. Borg, and K. White. Measurement and evaluation in the schools. 1993.

[83] Marilynn B Brewer. Research design and issues of validity. *Handbook of research methods in social and personality psychology*, 2000.

[84] Berbaum Kennedy, Lane and Lilienthal. Simulator Sickness questionnaire. 1993.

[85] Wohlin, P. Runeson, M. Host, C. Ohlsson, B. Regnell, and A. Wesslen. Experimentation in software engineering: an introduction. 2000.

[86] Preece, J. and Rogers, Y. and Sharp, Y. *Interadtion Design beyond human-computer interaction*. John Wiley & Sons Inc, 2002.

Appendix

A | Test Plan - Presence Test

Test plan - Presence Test

1. Overall goal:

The goal is to establish how immersive the traffic simulation is, and also to find out if the participants feels present in it. This test is meant to determine design inconsistencies and problem areas that the user does not find realistic, or takes away the feeling of presence. Furthermore, this test shall determine if the users experience simulation sickness, which might take away the feeling of presence from the users. Also, the goal is to determine which of two different versions of the simulation to use on the test on teenagers.

- Presence: Measure how present the participants felt during the simulation.
- Awareness: Measure how aware the participants were on the real world during the simulation.
- Realism: Measure how realistic the participant experienced the simulation to be.
- Distraction: Measure the quality of the simulation by finding out if the lags and delays were distracting.
- Immersion: Measuring how engaging and involving the participant experienced the simulation to be.
- Feelings and reactions: Measure if the participants got uncomfortable feelings and reactions connected to traffic accidents by trying the simulation.
- Measure simulation sickness.
- Find out what version to use.

2. Practical

- What is tested: Oculus Traffic Simulation
- Where: IDI room 354
- When: 5. mars
- Equipment: Oculus Rift, Headset, Computer able to run VR games.

3. Participants

- 11 Students.

4. Conduction

1. Pilot Test:

Discover possible weaknesses in the methodology in advance.
Practice conducting the test.
Get to know the software.

2. Background:

Using a questionnaire to get their background information.

3. Introduction:

- Explain who I am.
- Why they are here:
    - Adapt their expectations to the game.
- Introduce thesimulation, and what is going to happen.
- Ask them to answer as honest as possible
- Introduce equipment and how it works.
- Explain expectations. Thinking aloud
- Explain that it is the system that is tested and not them.
- Explain that they can withdraw and ask questions at any time.
- Explain that there will be time to discuss this afterwords
- Ask if they have any questions

4. Calibrate equipment:

- Calibrating and making equipment ready.
- Positioning the user.
- Start test.

5. Run Simulations:

- **First 5 participants**:
    1. Run passenger seat-simulation
    2. Run driver seat simulation
- **Last 6 participants:**
    1. Run driver seat simulation
    2. Run passenger seat-simulation

6. Interview:

- See interview guide

7. Questionnaire - Presence

- See questionnaire

8. Questionnaire - Simulation Sickness

- See questionnaire

9.Debriefing:

- Tell the user that their help was useful.
- Ask how they experienced it.
- Ask if they have any questions.

5. Metrics

Critical Errors

- Critical errors are problem areas that significantly takes away immersion and presence from the simulation.
- Problems that generates simulation sickness
- Examples:
    - Person gets so sick that they cannot focus on simulations or has to abort the test.
    - Something feels/ is experienced as completely unrealistic.

Non-Critical errors

- Non-Critical errors are minor problems that slightly lowers the participants feeling of immersion and presence.

Subjective Evaluations

- This will be evaluated through the questionnaire and the interviews during debriefing at the conclusion of the session.

Presence Test Objectives:

Determine simulation version to use:

-

Presence questionnaire:

- Get scores over average limit for the scale on positive loaded questions
- Get scores below average limit for the scale on the negative loaded questions

Simulation Sickness questionnaire:

- Get scores below average limit for the scale on all the questions.

Completion rate:

- Completion rate is the percentage of test participants who complete the test without any critical errors.
- The goal to have no critical errors, which means 100% completion rate.

Error-free rate:

- Error-free rate is the percentage of test participants who complete the test without any errors (critical or noncritical errors).
- The goal is 80 %

Frequency:

- Frequency is the percentage of participants who experience the problem when working on a task.
- High: 30% or more of the participants experience the problem
- Moderate: 11% - 29% of participants experience the problem
- Low: 10% or fewer of the participants experience the problem

Subjective Measures

- Overall feedback from interviews and questionnaire.

B | Written Consent Form - Presence Test

Samtykkeerklæring

"Brukertest" av Oculus Rift simulering.

Jeg har mottatt informasjon om forskningsprosjektet, og har fått anledning til å stille spørsmål. Jeg er klar over at det er frivillig å delta, og at jeg kan trekke meg når som helst uten å oppgi noen grunn.

Jeg samtykker i å delta i studien.

Trondheim,_____

_____

Underskrift

C | Background Form - Presence Test

Bakgrunnsinformasjon:

Alder (fyll ut)**:**

Kjønn (sett ring rundt)**:**

Kvinne Mann

Har du lett for å bli bilsyk/bevegelsyk (sett ring rundt)**:**

Ja Nei

Har prøvd Oculus Rift tidligere (sett ring rundt)**:**

Ja Nei

D | Presence Questionnaire

Noen spørsmål om simuleringen

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig
Tilstedeværelse:					
1. Jeg følte stor grad av tilstedeværelse under simuleringen.	1	2	3	4	5
Bevissthet: Under simuleringen var jeg…					
2. bevisst på den virkelige verden rundt meg.	1	2	3	4	5
3. bevisst på hendelser rundt meg i den virkelige verden.	1	2	3	4	5
4. bevisst på lyder rundt meg i den virkelige verden.	1	2	3	4	5
5. bevisst på menneskene rundt meg i den virkelige verden.	1	2	3	4	5
Realisme:					
6. Byen/Miljøet/Verden var realistisk.	1	2	3	4	5
7. Bilen jeg satt i var realisisk.	1	2	3	4	5
8. Trafikken virket realistisk.	1	2	3	4	5
9. Kjøringen/bevegelsen gjennom byen føltes realistisk.	1	2	3	4	5
10. Personene i bilen virket realistisk.	1	2	3	4	5
11. Personene i byen virket realistisk.	1	2	3	4	5
12. Kollisjonen minnet om en ekte bilulykke.	1	2	3	4	5

	Sterkt uenig				Sterkt enig
Distraksjoner:					
13. Kvaliteten på det visuelle var distraherende.	1	2	3	4	5
*14. “Lags” og “delays” var distraherende under simuleringen.	1	2	3	4	5
Engasjerende/Involverende:					
15. Jeg ble “revet med” av simuleringen.	1	2	3	4	5
16. Jeg levde meg inn i simuleringen.	1	2	3	4	5
17. Jeg følte meg involvert i simuleringen.	1	2	3	4	5
Lyd:					
18. Jeg kunne identifisere ulike lyder under simuleringen.	1	2	3	4	5
19. Lydene fikk simuleringen til å oppleves mer realistisk.	1	2	3	4	5
20. Lydene gjorde at jeg følte meg mer involvert i simuleringen.	1	2	3	4	5
Følelser og reaksjoner:					
21. Simuleringen gav en ubehagelig/skremmende følelse knyttet til trafikkulykker.	1	2	3	4	5

* Handlinger gjort sammenlignet med forventningene til hva bildet skal vise stemmer ikke overens. Dette er fordi det visuelle henger etter.

E | Simulation Sickness Questionnaire

No____ Dato_____

Spørreskjema - Simuleringssyke

Symptom	Ingen	Svakt	Moderat	Sterkt
Ubehag generelt				
Tretthet/utmattelse				
Hodepine				
Slitne/tretthet i øyne				
Vanskeligheter å fokusere				
Økt spyttproduksjon				
Økt svetteproduksjon				
Kvalme				
Konsentrasjonsvansker				
*Vertigo				
Ser uklart				
Svimmelhet (øyne åpne)				
Svimmelhet (øyne lukket)				
Følelse av press/trykk i hodet				
Ubehag i magen				
Raping				
Annet (beskriv):				

*Vertigo oppleves som svimmelhet eller en følelse av at omgivelsene går rundt.

F | Semistructured interview- Presence Test

Noen spørsmål om simuleringen

1. Hvilken versjon var mest realistisk? Den i førersetet, eller den i baksetet?
2. Noe som burde vært gjort for at simuleringen skulle vært bedre?
3. Hva kunne vært gjort for å få en sterkere følelsessmessig opplevelse knyttet til en trafikkulykke?
4. Noe annet du har lyst å legge til om hva som var bra eller dårlig?
5. Er det noe som du ikke har fått sagt som du har lyst å legge til?

G | Test Plan - Persuasive Test

Test plan - Persuasive Test

1. Overall goal:

The goal is to establish if each of the three medias (the simulation, the campaign video and RLA) are considered persuasive. In other words, if they can persuade the target users to avoid risky behavior in traffic. Furthermore, to reveal which medium is considered the most persuasive. Lastly, to discover possible positive or negative factors related to behavior change regarding such technologies.

2. Practical

- What is tested: Oculus Traffic Simulation, campaign video, Real Life Auto Introduction video.
- Where: NESP Usability Lab Oeya
- When: 19. - 20. and 26. -27. mars
- Equipment: Oculus Rift, Headset, Computer able to run VR games, campaign video, camera, audio recorder.

3. Participants

- 10 participants age 17-21.

4. Conduction

4.1 Pilot Test:

- Discover possible weaknesses in the methodology in advance.
- Practice conducting the test.
- Get to know the software.

4.2 Background:

- Using a questionnaire to get their background information.

4.3 Introduction

- Explain who I am.
- Why they are here:
    i. Adapt their expectations to the simulation.
- Introduce the simulation and other mediums, and what is going to happen.
- Ask them to answer as honest as possible
- Introduce equipment and how it works.
- Explain expectations. Thinking aloud
- Explain that it is the system that is tested and not them.
- Explain that they can withdraw and ask questions at any time.
- Explain that there will be time to discuss this afterwords.

- Ask if they have any questions.

4.4 Calibrate equipment

- Calibrating and making equipment ready.
- Positioning the user.
- Start test.

4.5 Test

- **Randomize the order of the simulation, introduction video and campaign video:**
    1. Run Oculus driver seat simulation.
    2. Answer questionnaire Attitude, Behavior, Perception regarding simulation.
    3. Watch Real Life Auto introduction video.
    4. Answer questionnaire Attitude, Behavior, Perception regarding the introduction video.
    5. Watch Campaign Video.
    6. Answer questionnaire Attitude, Behavior, Perception regarding campaign video.

4.6 Card Ranking

- Rank cards depending on which medium the participant feels has the most persuasive effect on behavior change when it comes to risky behavior in traffic
- Explain why it is ranked as it is.

4.7 Interview

- See interview guide

4.8 Debriefing

- Tell the user that their help was useful.
- Ask how they experienced it.
- Ask if they have any questions.

5. Objectives:

Attitude, Perception, questionnaire:

- Get scores over average limit for the scale on positive statements
- Get scores below average limit for the scale on the negative statements

Card ranking:

- Quantitative: Find a significant difference between media.
- Qualitative: Reveal which is considered most persuasive., and discover positive and negative factors.

Semi-structured interviews:

- Qualitative: Reveal if the any of the medias are considered persuasive
- Qualitative: Reveal positive or negative factors that impact persuasion.

H | Written Consent Form - Persuasive Test

Samtykkeerklæring

Test av Oculus Rift simulering.

Jeg har mottatt informasjon om forskningsprosjektet, og har fått anledning til å stille spørsmål. Jeg er klar over at det er frivillig å delta, og at jeg kan trekke meg når som helst uten å oppgi noen grunn.

Det vil bli tatt lydopptak og video av testen. Dette gjøres for at vi skal kunne analysere det som har skjedd i etterkant og for å sikre oss at vi har forstått utsagn og handlinger riktig. Vi vil sørge for at materiale vil bli anonymisert slik at det ikke vil være mulig å føre opplysningene tilbake til enkeltpersonene som deltar i prosjektet. Det er kun de involverte i prosjektet som vil kunne se opptakene i ettertid.

Vi forbeholder oss retten til å bruke anonymiserte i oppgaven vår.

Jeg samtykker i å delta i studien.

Trondheim,_____

_____

Underskrift

I | Background Form - Persuasive Test

No____ Dato_____

Bakgrunnsinformasjon:

- **Alder** (fyll ut)**:**

  ☐

- **Kjønn :**
  - ❑ Kvinne
  - ❑ Mann

- **Jeg har prøvd Oculus Rift tidligere:**
  - ❑ Ja
  - ❑ Nei

- **Jeg har førerkort til bil:**
  - ❑ Ja
  - ❑ Nei

- **Jeg har opplevd en bilulykke:**
  - ❑ Ja
  - ❑ Nei

J | Questionnaires - Attitude, Behavior and Perception

Noen spørsmål om Kampanjevideoen.

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig
Holdning:					
1. Tror du din holdning til risiko i trafikken har endret seg etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2. Tror du ungdom's holdning til risiko i trafikken endrer seg etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Adferd:					
3. Tror du din oppførsel i trafikken blir mindre risikofylt etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4. Tror du ungom's oppførsel i trafikken blir mindre risikofylt etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Oppfatning:					
5. Har du fått et nytt perspektiv på risiko i trafikken etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6. Tror du ungdommer sitt perspektiv på risiko i trafikken endrer seg etter å ha sett kampanjevideoen?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Noen spørsmål om hensikten med RLA.

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig
Holdning:					
1. Tror du din holdning til risiko i trafikken har endret seg etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2. Tror du ungdom's holdning til risiko i trafikken endrer seg etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Adferd:					
3. Tror du din oppførsel i trafikken blir mindre risikofylt etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4. Tror du ungom's oppførsel i trafikken blir mindre risikofylt etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Oppfatning:					
5. Har du fått et nytt perspektiv på risiko i trafikken etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6. Tror du ungdommer sitt perspektiv på risiko i trafikken endrer seg etter å ha spilt RLA?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Holdning, Aderd og Oppfatning.

Vennligst sett kryss i kun en rute pr. spørsmål.

	Sterkt uenig				Sterkt enig
Holdning:					
1. Tror du din holdning til risiko i trafikken har endret seg etter å prøvd simuleringen?	1	2	3	4	5
2. Tror du ungdom's holdning til risiko i trafikken endrer seg etter å ha prøvd simuleringen?	1	2	3	4	5
Adferd:					
3. Tror du din oppførsel i trafikken blir mindre risikofylt etter å ha prøvd simuleringen?	1	2	3	4	5
4. Tror du ungom's oppførsel i trafikken blir mindre risikofylt etter å ha prøvd simuleringen?	1	2	3	4	5
Oppfatning:					
5. Har du fått et nytt perspektiv på risiko i trafikken etter å ha prøvd simuleringen?	1	2	3	4	5
6. Tror du ungdommer sitt perspektiv på risiko i trafikken endrer seg etter å ha prøvd simuleringen?	1	2	3	4	5

K | Card Ranking

No____ Dato_____

Card Ranking

Rank cards dependent on which media the participant feels has the most persuasive effect on behavior change when it comes to risky behavior in traffic on target audience. Explain why it is ranked as it is.

1. **Highest Ranked**

2. **Second highest Ranked**

3. **Lowest Ranked**

L | Semistructured interview - Persuasive Test

No____ Dato_____

Intervjuspørsmål

Oculus Rift Simulering:

- **Følelser knyttet til simuleringen:**
    1. Hva synes du om simuleringen?
    2. Minnet dette om en trafikkulykke?
    3. Hvordan følte du deg rett før kollisjonen? Fikk du lyst til å ta i rattet å endre situasjonen?
    4. Følte du at du hadde kontroll?
    5. Hva følte du etter kollisjonen? Var en ubehagelig opplevelse? Hvorfor/Hvorfor ikke?
    6. Tror du dette kan skape et ubehag knyttet til trafikkulykker hos andre? Hvorfor/Hvorfor ikke?

- **Konkrete om simuleringen:**
    7. Hva synes du om bilen? Var den realistisk?
    8. Menneskene?
    9. Byen?

- **Holdning, adferd, oppfatning knyttet til simuleringen:**
    10. Tror du dette kan være med å endre holdning til ungdom i dag? /Hvorfor/Hvorfor ikke?
    11. Tror du dette kan være med å endre adferd til ungdom i dag? /Hvorfor/Hvorfor ikke?

- **Innlevelse:**
    12. Ble du “revet med” av simuleringen?
    13. Var simuleringen engasjerende/involverende?
    14. Levde du deg inn i i simuleringen?

- **Fremtidig bruk av Oculus Rift og Trafikkopplæring:**
    15. Tror du Oculus Rift kan være nyttig til andre ting når det gjelder trafikk opplæring?
    16. Hva tror du fokuset bør være på/bør forskes mer på når det gjelder holdningsendring til risiko i trafikken. Hvorfor?

No____ Dato_____

Intervjuspørsmål

Kampanjevideo:

- **Følelser knyttet til:**
    1. Hva synes du om videoen?
    2. Synes du den gav en ubehagelig opplevelse knyttet til trafikkulykker?

- **Holdning, adferd, oppfatning knyttet til simuleringen:**
    1. Tror du dette kan være med å endre holdning til ungdom i dag? /Hvorfor/Hvorfor ikke?
    2. Tror du dette kan være med å endre adferd til ungdom i dag? /Hvorfor/Hvorfor ikke?
    3. Synes du den var effektiv når med tanke på holdningskampanjer? Tror du den eller andre kampanjevideoer endrer holdninger og adferd? Hvorfor/Hvorfor ikke?

- **Innlevelse:**
    1. Ble du “revet med” av kampanjevideoen?
    2. Levde du deg inn i i videoen?

No____ Dato_____

Intervjuspørsmål

Dataspill- “Real Life Auto”

- **Følelser knyttet til:**
    3. Hva synes du om RLA?
    4. Synes du spillet gav en ubehagelig opplevelse knyttet til trafikkulykker?
- **Holdning, adferd, oppfatning knyttet til simuleringen:**
    1. Tror du dette kan være med å endre holdning til ungdom i dag? /Hvorfor/Hvorfor ikke?
    2. Tror du dette kan være med å endre adferd til ungdom i dag? /Hvorfor/Hvorfor ikke?
- **Innlevelse:**
    1. Ble du “revet med” av spillet?
    2. Var spillet engasjerende?
    3. Levde du deg inn i i spillet?

No____ Dato_____

Intervjuspørsmål

Diskusjon:

- **Din mening om hva som vil fungere:**

1. Dere fikk i oppgave å gjøre dette her. Hva vil dere gjøre? Hva tror dere vil fungere? Hvorfor? Hva er det som kan føre til endringer? Brukt disse mediene, eller satset på noe helt annet. Hva tror du?